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Heating · Piping and Air Conditioning

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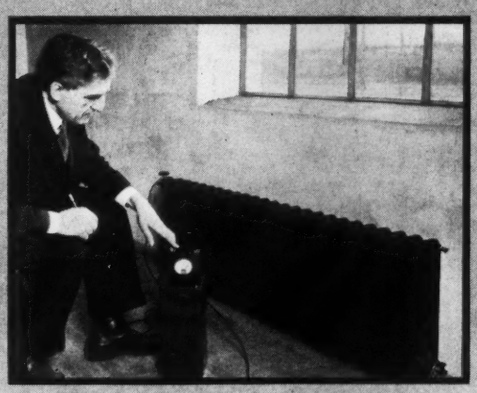

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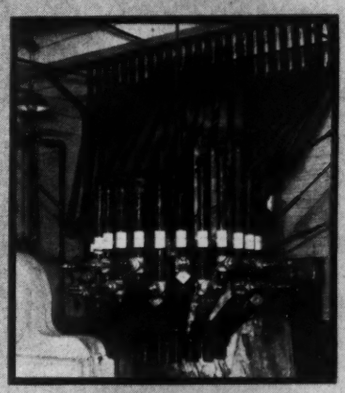

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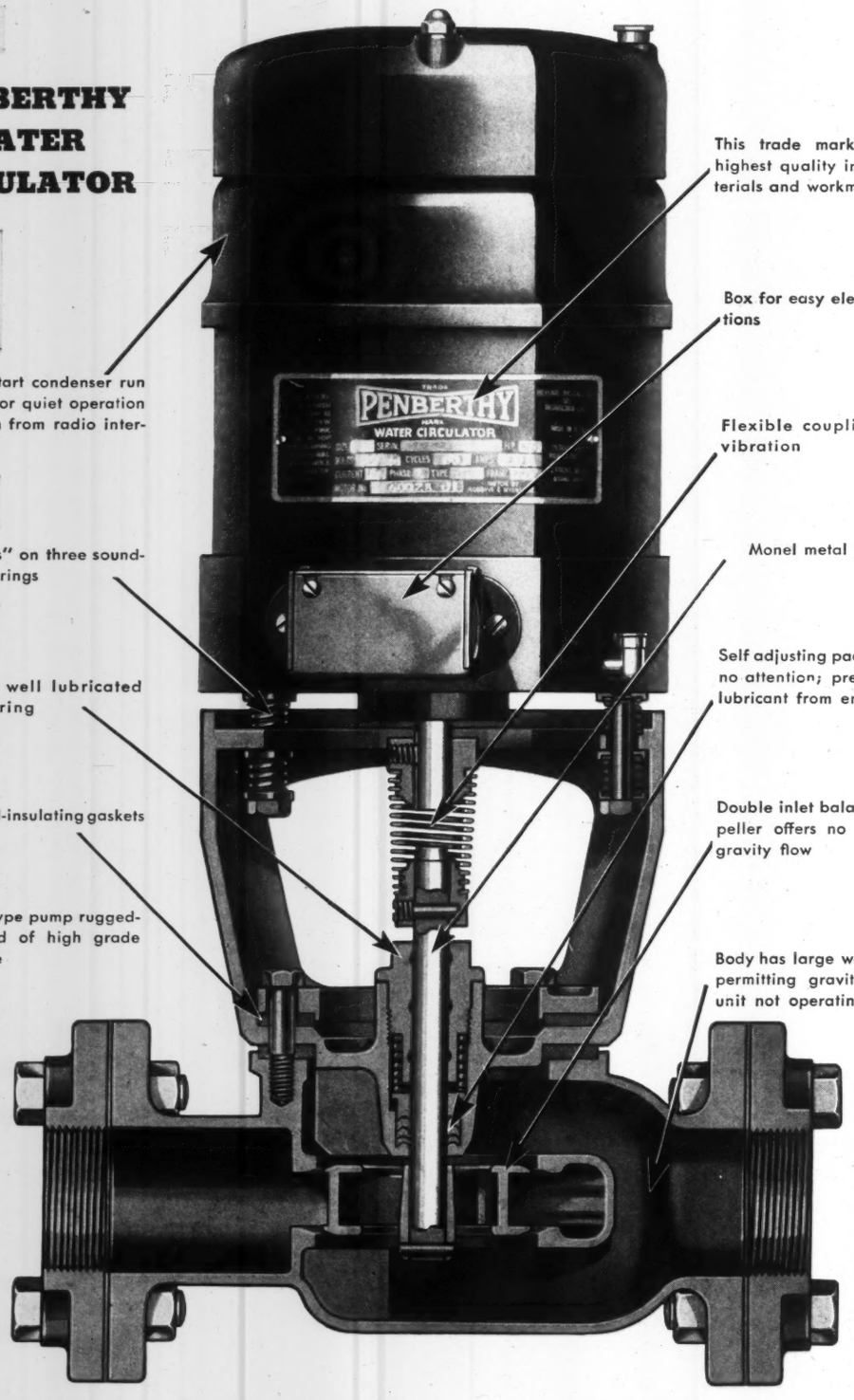

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THIS month—Where the production schedule depends upon the piping facilities—as in a paint and varnish plant, for instance—manufacturing efficiency is largely dependent upon suitable layout of the piping systems. The piping and the pumping equipment must be arranged to permit flexibility in operation, for one thing. Careful piping design and installation often is required, as several piping systems may be needed in restricted space . . . S. I. Rottmayer describes the process piping layout in a paint and varnish plant this month, his description being illustrated by a number of excellent photographs which indicate clearly the problems involved.

A chart developed by William Goodman for solving problems which arise in the use of air washer type coolers in industrial and comfort air conditioning work is reproduced in this issue, and its applications are explained. Several examples show solution of typical problems involving single stage air washers, and a second article will cover two stage counterflow coolers and two stage split air washers . . . Without such a chart, solution of problems of this kind is often a tedious "trial and error" process.

Erwin L. Weber describes a method of equalizing hot water heating systems which he uses, and explains the necessity for balancing the flow to the units of radiation with this type of heating . . . The same principle can also be used for balancing brine cooling coils, and for quickly locating leaky radiator traps on vacuum and vapor systems.

Design of a bulk fuel oil storage plant must be such that handling costs are economical. Kalman Steiner describes a recently erected plant of this kind in his article appearing this month, discussing location of the plant, determination of the required storage capacity, structural considerations, design of the main storage tanks, etc. . . . A later article will detail the design of the pumping and piping equipment, design of heating coils in the tanks, and the boiler plant and heating of the buildings.

"DON'T jump at conclusions when trouble-shooting," is T. H. Rea's advice; he describes what was apparently faulty operation of one of two traps for draining the cylinders of a dry milk machine, shows that the real trouble was a leak in a syphon pipe . . . An important application of the stroboscope not in general use is the study of the flow of air as it passes through the blades of a fan, according to Harold E. Edgerton of M. I. T. An interesting picture of a vortex of smoke at the tip of a blade of an ordinary desk fan is reproduced this month, with a brief description of the method by which it was obtained . . . How closer control of heating was secured by lowering a diaphragm valve to make its operation more sensitive is described in a short article by H. G. Schaefer in this issue . . . Edgar S. Miller suggests and defines "thermohygrics"; what do you think of his proposal?

JOURNAL Section of the *American Society of Heating and Ventilating Engineers*—The A.S.H.V.E. Journal Section includes papers on "Classroom Odors with Outside Air Supply" and "Air Diffusion in Ventilation Systems."

THE "back of the book"—In the back section are the regular departments on recent developments in heating, piping and air conditioning equipment; reviews of books and booklets; recent trade literature, convention and exposition dates; correspondence. A coupon on page 95 is for your convenience in getting detailed information about equipment described this month, or copies of the trade literature which is reviewed.

THAT modernization of business properties (stores, shops, restaurants, office buildings, countless other types of commercial structures—"Main Street, for short) is a paying proposition has been proved by many examples. Installation of air conditioning has been shown to be a business getter and holder; bringing an old heating system up-to-date has reduced operating costs and resulted in better heating service. Numerous descriptions of heating and air conditioning modernization and the results secured have been reported in these pages, have stimulated similar programs for other buildings . . . A bill before the Senate which provides for increasing the limit of modernization loans under the housing act from $2,000 to $50,000 is expected to stimulate modernization of "Main Street," allow many projects for which plans are available to go ahead.

A NUMBER of weather bureau stations are now showing degree days for the month on the "Monthly Meteorological Summary," which is issued about the 5th of the following month; previously the mean temperature for each day was shown from which degree days could be computed by subtracting the mean temperature for each day from 65 F, the base temperature . . . Numerous requests to several stations for degree day data lead to inclusion of the degree day figure . . . The monthly summary is designated as "Form No. 1030," is mailed regularly upon request to the weather bureau.

THE proposed code for pressure piping developed by *A. S. A.* sectional committee B31, sponsored by the *American Society of Mechanical Engineers*, has been submitted to the *American Standards Association* for approval as a tentative standard; the code consists of sections on power, gas and air, oil, and district heating piping systems, fabrication details, materials, and specifications and identification . . . The code was reviewed by Sabin Crocker in a noteworthy series of articles published in H.P.&A.C. last year.

THE chaos in building codes is a challenge to the standards movements, according to the *American Standards Association;* a National Bureau of Standards survey has shown that some cities have codes written more than thirty years ago . . . Methods of combatting silicosis in coal mines were described at a symposium at the recent meeting of the *American Institute of Mining and Metallurgical Engineers;* better mine ventilation and spraying air passages with water have aided to lower the incidence of silicosis in coal mine workers, according to Dr. Donald E. Cummings of the Saranac Laboratory for the Study of Tuberculosis . . . Theodore Hatch of Harvard Engineering School described a new hollow rock drill through which flows air to blow the dust out through the bore hole into a hood connected with the mine exhaust system.

"I HAVE heard it said that the trouble with the air conditioning business is that there are too many engineers in it. Maybe so. Personally, I think it is worth while analyzing any job from an engineering standpoint to determine: First, what properties of air we wish to control; second, what are the outside influences that will tend to create undesirable conditions; third, what can be done to the structure to eliminate or prevent these influences so far as possible; and fourth, what is the available equipment best suited to supply and control the conditions . . . The

[*Continued on p. 84, back section*]

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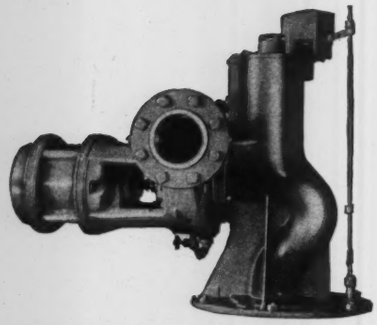

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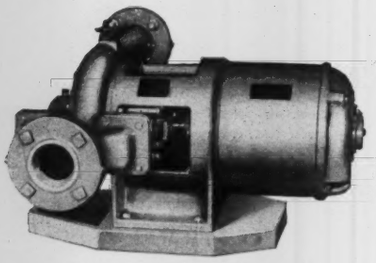

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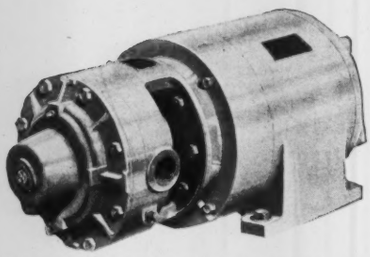

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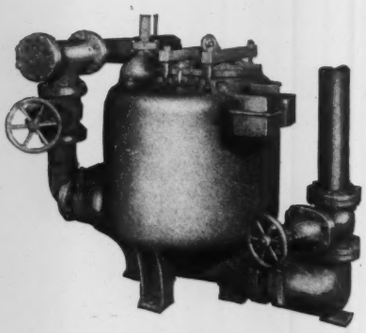

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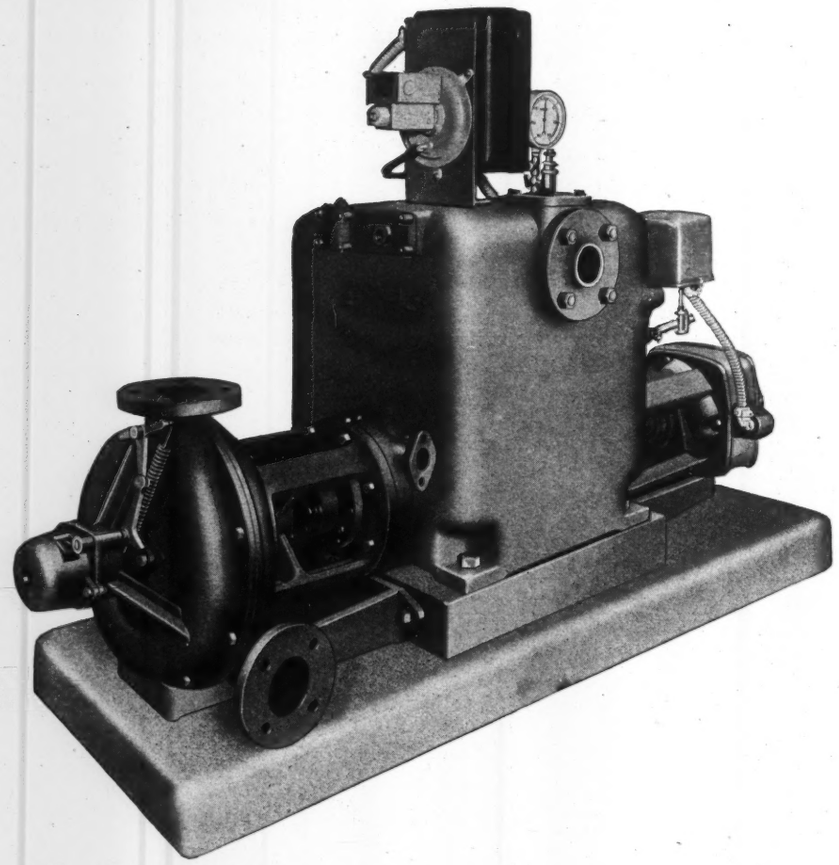

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Heating · Piping and Air Conditioning

Vol. 7, No. 5 • May, 1935

New Process Piping Layout Speeds Paint Production Schedule

By S. I. Rottmayer*

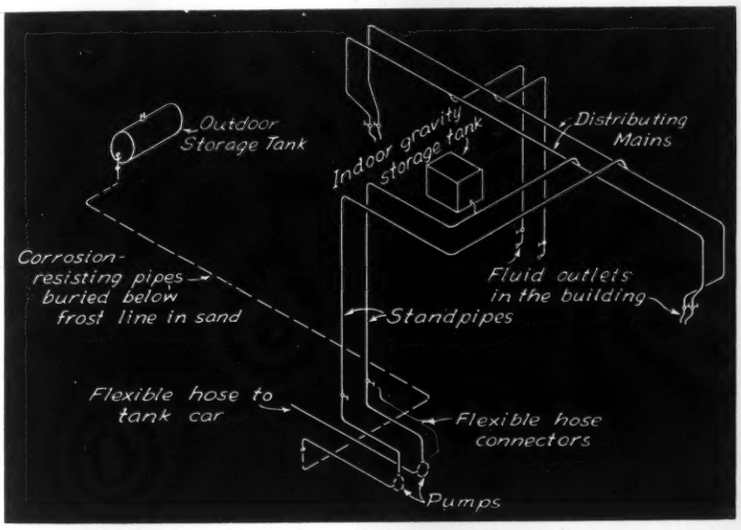


Fig. 1 — Schematic diagram of a single pipe line for each system

WHEN expansion of a large paint and varnish company's activities called for replanning its production program, a high speed production schedule was evolved around a flexible system of piping arranged to distribute a large number of fluids from storage tanks to the points in the plant where they are used. More than 17,000 linear feet of 2 and 2½ in. pipe were used in this interesting piping installation, which has just been completed.

Two systems of storage tanks are employed:—One group of tanks containing highly volatile fluids and bulky liquids such as naphtha, benzene, linseed oil, soy bean oil, etc., are located outside the manufacturing building, and a group of 25 storage tanks containing less volatile liquids, such as varnishes, stains, etc., are located inside a new building addition on a floor elevated one story above the rest of the plant. Fluids in these tanks flow by gravity through piping to their points of use. Fluids from the outside storage tanks are distributed through the plant under pump pressure, the pump motors being under remote control from switches located on each valved outlet from any main.

*Mechanical Engineer, Chicago, Ill.

Raw materials and liquids are received in tank cars on a railroad siding, or by tank trucks. Liquids for storage in the outside tanks may be unloaded by pumps located at the tanks. Liquids for storage in the top story inside tanks may be unloaded by pumps located on the ground floor of the storage tank building. Piping is arranged to give flexibility to the use of the ground floor pumps for filling any inside storage tank.

A schematic diagram of a single pipe line for each system is shown in Fig. 1. The battery of 9 ground story pumps, Fig. 2, normally serves pipe lines from outside-stored liquids and serves also as unloading pumps for the gravity storage tanks. This is accomplished by the use of flexible hose connections between the pumps and any standpipe. In Fig. 2 one pump is shown connected with a flexible hose to a standpipe in the center group.

Fig. 3 illustrates the piping at the ceiling immediately below the gravity storage tanks. The standpipes extend from the pump floor to this ceiling at the left of the view, then run horizontally as shown to a point below the storage tank where the valved connections illustrated are made to the storage tanks above. These pipes then extend into the manufacturing building at the right of the picture. Long radius elbows and drainage fittings are used to reduce friction.

Supporting the Piping

Trapeze hangers for the horizontal piping are made of 3½ in. pipe suspended with solid rods from beam clamps. Cross-hangers of smaller pipe for shorter spans are welded to the 3½ in. pipe.

In many plants process piping plays an important part in the production schedule, and consequently the arrangement of the piping to permit efficient plant operation is of great importance. Described here are the piping systems installed in a large paint and varnish company plant when expansion of the company's activities made it necessary to speed up the production program. . . . A piping project of this kind presents real problems, as many different fluids must be conveyed to several different points. Flexibility of operation is essential; hanging the piping from the building structure is often a problem (17,000 feet of piping were used on this job, for instance); providing a terminus at one point for 26 different pipe lines required careful design and accurate workmanship on the part of the pipe fitters.

●

The weight of vertical piping in the building is carried on pairs of heavy strap iron clamps, forged to fit the pipe, bolted to the pipe at the floor line of alternate stories immediately below a coupling.

Fig. 4 is a view of the distributing mains at the ceiling of the top story of the manufacturing building; these mains are 200 ft long. The hangers were set with a surveyor's level to give a pitch of 6 in. in that length; structural considerations prevented a greater pitch. Over a mile of pipe is installed on this floor.

The pipes from the gravity storage tanks enter from the right in the distance and drop in the tops of these longitudinal mains, only about half the length of which is shown. The pipes in the upper foreground connect from the bottoms of the longitudinal runs to outlets on lower floors. Extending laterally in the center foreground is a battery of pipes from the bottom of the mains to automatic fluid meters at the right and left.

Strap iron saddles, lag bolted into the wood building columns, support the ends of the 20 ft long trapeze hangers, and three intermediate solid rod supports are fastened to the roof joists. The trapeze hangers are made of 3 in. pipe and are spaced 12 ft on centers. Bolt and strap iron spreaders are installed at frequent intervals in the runs to maintain the 4½ in. center distance of the mains.

Terminus of 26 Piping Systems

Fig. 5 illustrates the terminus of 26 pipes above a platform scale on a lower floor. The required volume of any of the 26 fluids quickly can be drawn off into a ladle on the scale platform and weighed. These pipes, fastened with U-bolts, are spaced equally outside of a rolled 4 in. steel channel ring, 3 ft 6 in. in diameter. The ring is supported from the ceiling construction with four solid rod ties provided with turnbuckles. Open ends of the pipes are grouped within a 24 in. diameter circle. Each branch is so constructed that any pipe may be removed from the assembly.

Fig. 6 is a similar terminus at another point in the building. Neither ring is located symmetrically with respect to the centers of the groups of pipes. It was necessary to cut crooked threads on the pipes in these groups to connect them. Accurate workmanship of high quality was displayed by the pipe fitters.

The size of the piping to carry fluids by gravity from the elevated storage tanks was arrived at in the following manner: The maximum frictional resistance of the most viscous fluid when flowing in the piping at the specified rate to the highest outlet most distant from the storage tank must be less than the static head between the storage tank and the highest outlet.

Fig. 7 illustrates a point in the building where fluids will be drawn off into cans. Each line is provided at its outlet with a gate valve and an oil gate. The pipes are fastened with hook bolts to steel angles which in turn are lag bolted to the wall. Extensive use of a welding torch converted scrap steel into many of the hangers, anchors and supports for the piping.

Threaded joints in the piping are made with a pipe dope consisting of lead chloride, iron oxide and shellac. The property of shellac of being soluble only in alcohol dictated its use as a binder in the preparation of this dope. When set, the joint is sealed against leaks of the fluids carried in the piping system.

The pipes between the outdoor storage tanks, Fig. 8, and the pumps are made of a corrosion resisting alloy (copper molybdenum iron) and are coated with pitch and buried below the frost line in sand.

The piping system was tested under 45 lb air pressure before being put into service. Only two leaks were detected; one occurred at a sandhole in an elbow and one was due to a split pipe.

The piping contractor was Wm. F. Hildeman, Chicago Heights, Ill.

OPPOSITE

Fig. 2—A battery of 9 pumps normally serves the pipe lines from the outside storage tanks, and also serves for unloading the gravity storage tanks

Fig. 3—Piping at the ceiling immediately below gravity storage tanks

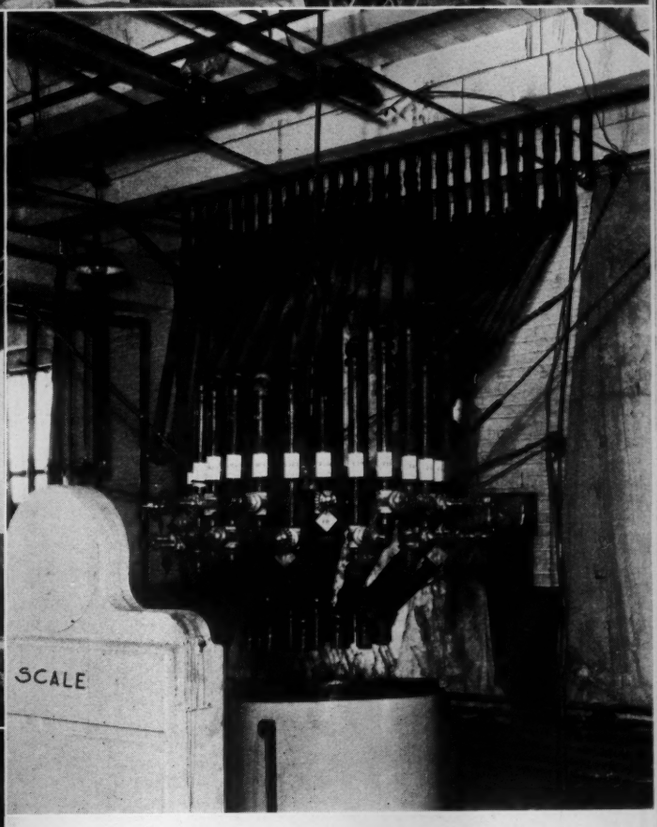
Fig. 4—Distributing mains at ceiling of top story of plant

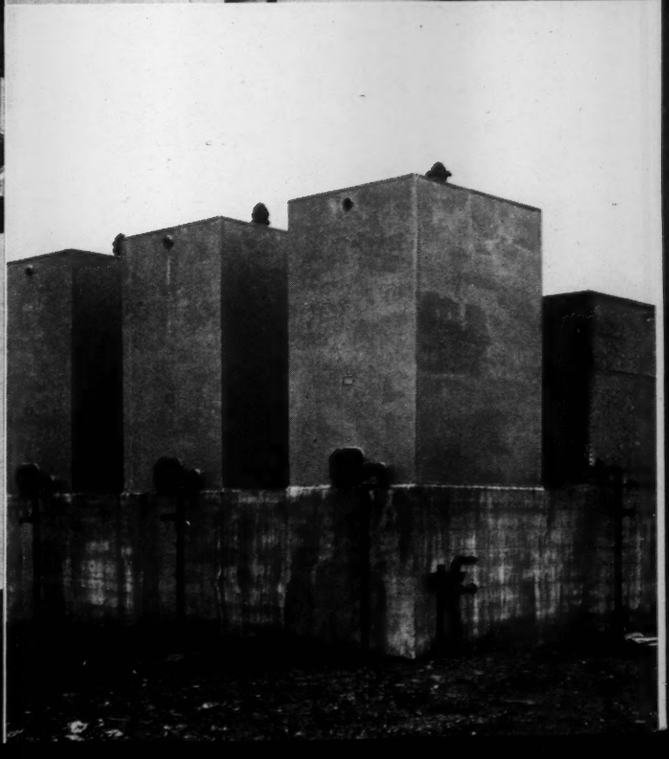
Fig. 5—Terminus of 26 piping systems above platform scale. The required amount of any of the 26 fluids can be quickly drawn off here and weighed

Fig. 6—Similar terminus to that shown at Fig. 5 at another point in the plant

Fig. 7—Here fluids can be drawn off into cans. Each line is provided with a gate valve and an oil gate

Fig. 8—Outdoor storage tanks


SCALE



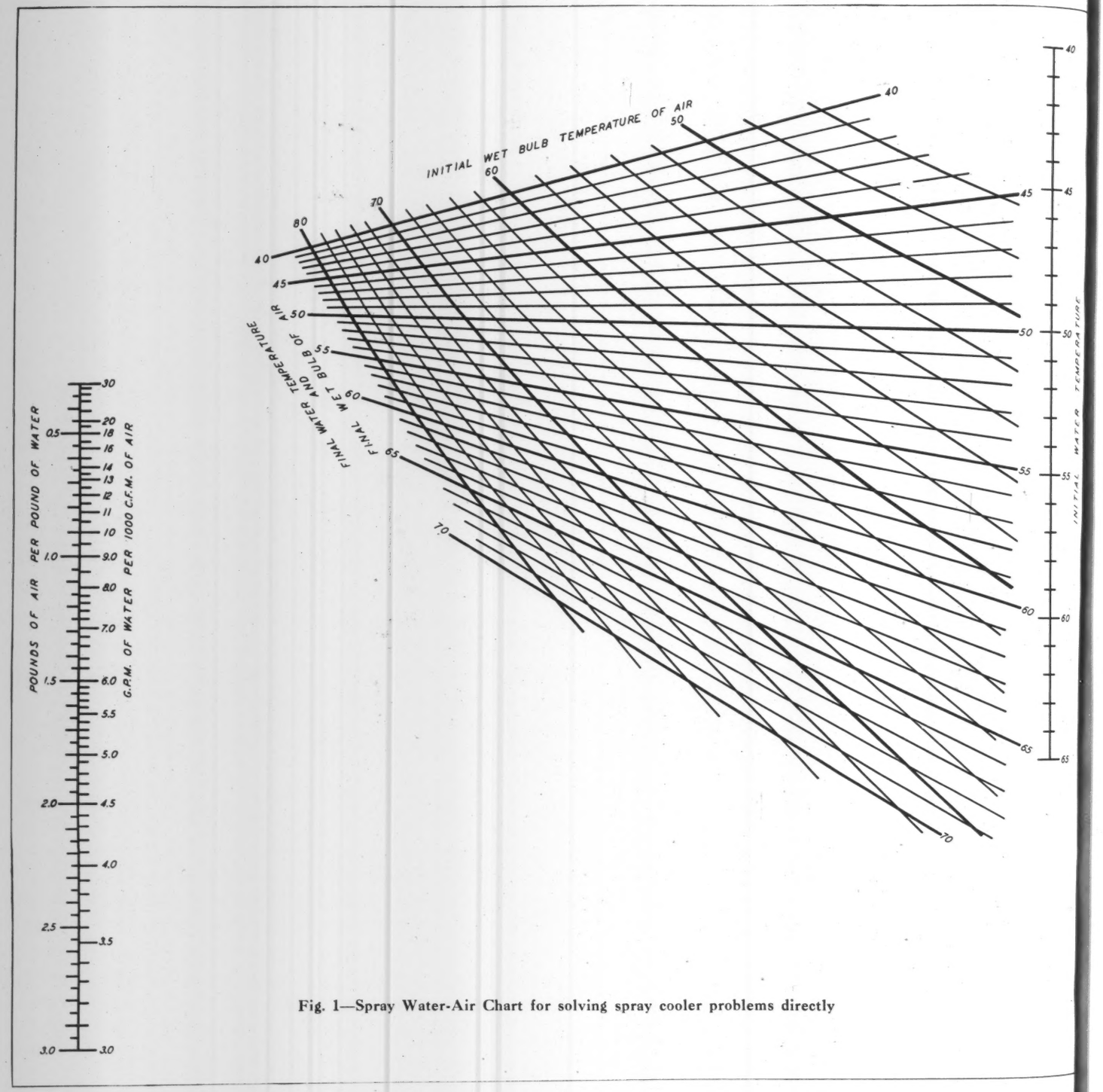

INITIAL WET BULB TEMPERATURE OF AIR
FINAL WATER TEMPERATURE AND WET BULB OF AIR
POUNDS OF AIR PER POUND OF WATER
G.P.M. OF WATER PER 1000 C.F.M. OF AIR
INITIAL WATER TEMPERATURE

Fig. 1—Spray Water-Air Chart for solving spray cooler problems directly

Many problems which arise in the use of spray water type coolers in industrial and comfort air conditioning can be solved only by tedious trial and error methods, especially so when two stage counterflow air washers are involved. The author has therefore prepared this spray water-air chart which simplifies the job by enabling direct solution of many spray cooler problems. . . . The author has taught classes in air conditioning, and has had a wide experience in the design, construction, and operation of air conditioning plants.

Air Conditioning Problems Solved by Spray Water—Air Chart†

By **William Goodman***

IN using spray type water coolers many problems arise which can be solved only by trial and error methods. This is especially true of problems involving two stage counterflow air washers. Any one who has ever tried to solve an engineering problem involving one of these can testify to the tedious hit or miss process involved.

In an attempt to simplify the solution of problems involving an exchange of heat between cold water and

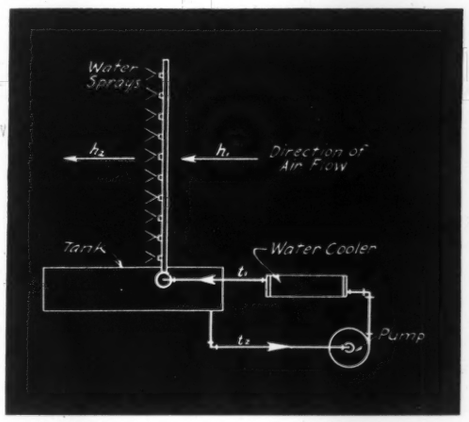


Fig. 2—Diagram of a single stage air washer

relatively warm air, the "Spray Water-Air Chart," Fig. 1, was prepared. With this chart, a direct solution of many spray cooler problems can be found.

A perfect spray cooler was assumed in preparing this chart. In such a cooler the final temperature of the air and the water will be exactly the same. In commercial washers, the final temperature of the air varies from 1 F and up above the final temperature of the air. So much depends upon the individual design of the washer that no attempt was made in this paper to allow for this difference. Each designer, knowing the characteristics of the spray cooler he is using, can make his own allowances and correct the theoretical results accordingly. In a well designed spray cooler, the final temperature of the air is very often within a few degrees of the final water temperature.

The construction of the chart is based on the following fundamental equation:

Heat gained by water = Heat lost by air.

or $W(t_2 - t_1) = w(h_1 - h_2)$

where

W = Weight of water circulated, lb per min.

w = Weight of air cooled, lb per min.

t_1 = Initial temperature of water (see Fig. 2), degrees Fahrenheit.

t_2 = Final temperature of water, degrees Fahrenheit.

h_1 = Total heat of the air-vapor mixture at the initial wet bulb temperature at which it enters the spray water cooler, Btu per lb.

h_2 = Total heat of the air-vapor mixture at the final wet bulb temperature at which it leaves the spray water cooler, Btu per lb.

Single Stage Washers

Fig. 2 is a diagram of a single stage air washer. Note that the temperature t_2 of the leaving water is equal to the temperature of the leaving air. This must be kept in mind in solving the following problems, which illustrate the use of the chart as applied to air washers or spray water coolers:

Problem 1—Water is available at 48 F. The initial wet bulb temperature of the air is 68 F. If the air is to be cooled to 54 F, how much water is required?

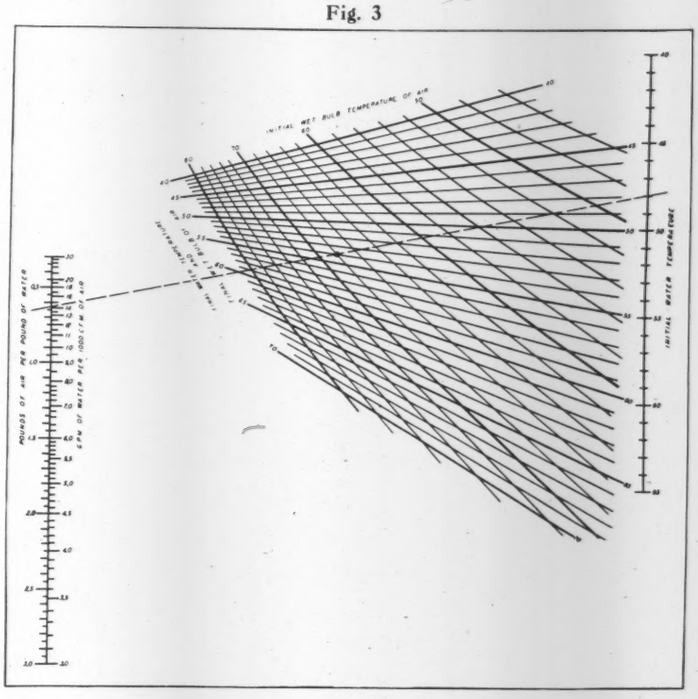
See Fig. 3. Lay one end of the straight edge on 48 F on the scale marked "Initial Water Temperature." Lay the other end of the straight edge on the net work at the intersection of the 68 F "Initial wet bulb of Air" line, and the 54 F "Final Wet Bulb of Air" line. Read 14.2 gpm on the "Gpm of Water" scale.

Answer: 14.2 gallons of water per 1000 cfm of air.

Check: Heat gained by water = Heat lost by air.

$$\frac{14.2 \times 8.33}{1000 \times 0.075} = \frac{14.2}{9} = 1.58 \text{ lb of water per lb of air.}$$

Fig. 3



†Copyright, 1935, by William Goodman.

*The Trane Co., La Crosse, Wis.

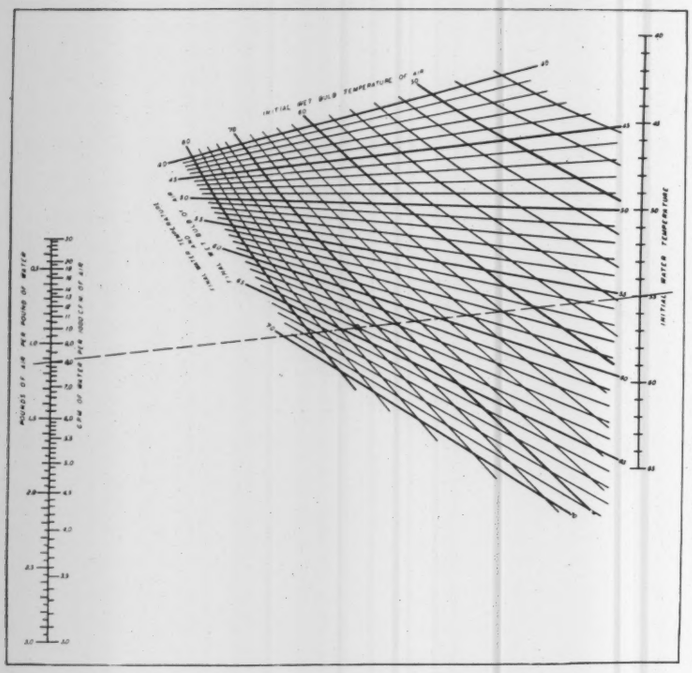


Fig. 4

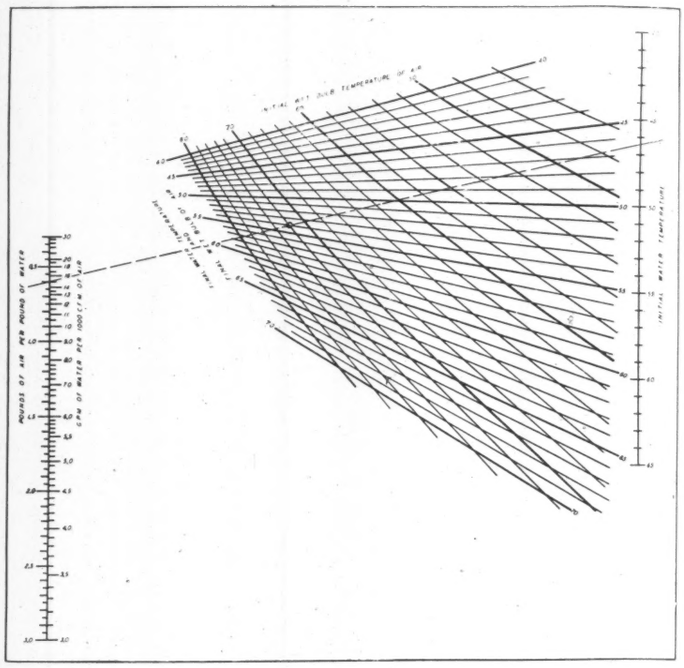


Fig. 5

Heat gained by water = 1.58 (54-48).
= 9.48 Btu per lb of air.
Heat lost by air = $(h_1 - h_2)$.
= 31.92 — 22.45) = 9.47.
(See table of "Total Heat of Air")

A problem of this kind is easily solved without the Spray Water-Air Chart, but problems such as the following, in which it is necessary to find the final temperature of the air can be solved more easily by the Spray Water-Air Chart, than by other methods. For example, first try to solve the following problem without the Spray Water-Air Chart:

Problem 2—8 gpm of water per 1000 cfm of air is available. The initial temperature of the water is 55 F. The initial wet bulb of the air is 74 F. What will be the final temperature of the air?

See Fig. 4. Lay one end of the straight edge on 55 F on the "Initial Water Temperature" scale. Lay the other end of the straight edge on 8 gpm on the "Gpm of Water" scale. Read 64 F on the "Final wet bulb of Air" scale at the intersection of the 74 F "Initial Wet Bulb of Air" line and the straight edge.

Answer: The air will be cooled to 64 F. This is also the final temperature of the spray water.

Check:

$\frac{8}{9}$ = 0.89 lb of water per lb of air.

Heat gained by water = 0.89 (64-55).
= 8.01 Btu per lb of air.
Heat lost by air = (36.9 — 28.93).
= 7.98 Btu per lb of air.

Problem 3—Air having an initial wet bulb temperature of 72 F is to be cooled to 54 F. If 15 gpm of water per 1000 cfm of air is available, what must be the initial temperature of the water?

See Fig. 5. Place one end of the straight edge on 15 gpm. Place the remainder of the straight edge so that it passes through the intersection of the 72 F initial air wet bulb temperature line and the 54 F final air temperature line. Then read on the "Initial Water Temperature Scale" the answer, 46.5 F, which is the required initial water temperature.

Problem 4—10.5 gpm of water per 1000 cfm of air is available. The initial temperature of the water is 42 F. What is the highest initial wet bulb temperature which the entering air may have, if this air must be cooled to a final temperature of 50 F?

Answer: The highest wet bulb temperature which the entering air can have is 65 F.

Correction of Theoretical Results

In the preparation of the "spray water-air chart" and in the solution of the preceding problems a perfect spray cooler was assumed. In such a cooler the final temperature of the water and the final wet bulb temperature of the air are assumed to be the same. In actual practice there is always some difference between these two final temperatures. As was stated, this difference varies from 1 F and up, although it is seldom as low as this. The method of correcting the theoretical results of the preceding problems to take this factor into account is simple and is presented in the following recalculation of Problem 2.

Problem 2 Recalculated—Taking the answer to Problem 2 we found that 7.98 Btu was removed from each pound of air. The initial water temperature was 55 F and the final water temperature 64 F, which means that each pound of water gained 9 Btu.

The amount of heat removed from the air in Problem 2 is the maximum attainable if we have a perfect spray cooler. In an average spray cooler the air would not be cooled to quite as low a wet bulb temperature and the water would therefore not be heated to quite as high a final temperature, because less heat would be available from the air to heat the water. Remember that even if there is a difference between the final tempera-

Total Heat of Air at Various Wet Bulb Temperatures

Wet Bulb, F	Total Heat, BTU Per Lb of Air	Wet Bulb, F	Total Heat, BTU Per Lb of Air
40	15.21	60	26.18
41	15.67	61	26.84
42	16.14	62	27.52
43	16.62	63	28.22
44	17.10	64	28.93
45	17.59	65	29.65
46	18.09	66	30.39
47	18.60	67	31.15
48	19.12	68	31.92
49	19.65	69	32.71
50	20.19	70	33.51
51	20.74	71	34.33
52	21.30	72	35.17
53	21.87	73	36.03
54	22.45	74	36.91
55	23.04	75	37.81
56	23.64	76	38.73
57	24.25	77	39.67
58	24.88	78	40.64
59	25.52	79	41.63

Reprinted by Permission from *Properties of Steam and Ammonia*, by the late G. A. Goodenough (John Wiley & Sons).

ture of the air and water, our first fundamental equation is still true; namely

Heat gained by water = Heat lost by air.

Therefore, if we say roughly that we can remove 85 per cent of the heat from the air with an actual cooler that we could with a theoretically perfect one, the total heat removed per lb of air will be 85 per cent of 7.98 = 6.8 Btu.

The initial heat content of the air at 74 F wet bulb is 36.9 Btu per lb of air.

The final heat content of the air equals 36.9 — 6.8 = 30.1 Btu per lb of air.

From the table of total heat of air, the wet bulb temperature of air having a total heat content of 30.1 Btu per lb of air is 65.6 F. This is the final wet bulb temperature of the air. The rise in water temperature, instead of being 9 F, will be 85 per cent of 9 or 7.7 F. Since the initial water temperature is 55 F the final temperature of the water will be 62.7 F.

Once knowing, by means of the spray water-air chart what results can be obtained with a perfect spray cooler, the correction to actual working conditions is easy. This explanation appears lengthy only because each step in the process has been analyzed in detail. To anyone who has grasped the underlying principle the actual arithmetical work involved is a matter of but a few minutes.

[The second part of this article will show the use of this chart in the solution of problems involving two stage counterflow coolers and two stage split air washers.—The Editor.]

"Thermohygric" — a Suggestion

By Edgar S. Miller*

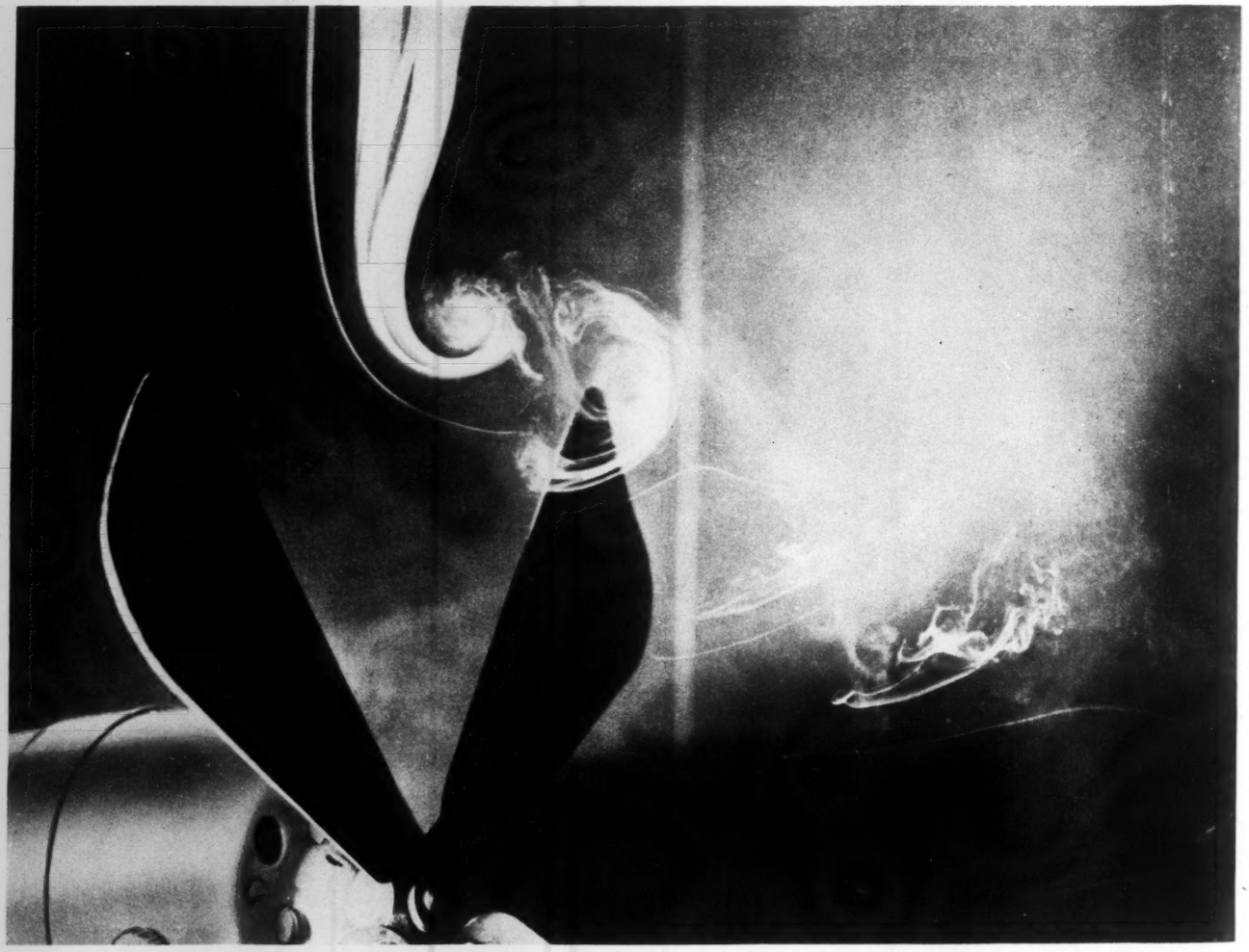
THE use of the term "heating and ventilating engineering" to designate that branch of science and art which has to do with the task of providing atmospheric conditions conducive to the comfort, efficiency and health of human beings is not only a trifle clumsy but somewhat out of tune with present-day conceptions. That this is so is evidenced by the wide use of the term "air conditioning," indicating, as it does, a rather general realization that "relative humidity" is something more than just a trick phrase.

But although 'air conditioning" does strike nearer the point, even it appears inadequate. Neither the heating nor ventilating nor "conditioning" of air fully encompasses all that is requisite for the accomplishment of the end desired; namely, "conditioning" the human body with respect to thermal comfort and helping keep it in a state of efficiency and health.

It would seem desirable therefore to try to find a word or phrase particularly appropriate and significant to the science or branch of science having to do with these problems. "Heating" does not tell the story; "ventilating," merely as such, is out. The behavior of heat and water—"moisture," preferably—as they act and react upon each other in air evidently cannot be ignored. Why not, then, use a term suggestive of both heat and moisture as well as of the actions and reactions involved?

A glance at the work of one Mr. N. Webster indicates that the word, "thermal," derived directly from the Latin and indirectly from the Greek, is actually about as indefinite as the old Saxon "heat." However, it is probable that it—and the combining form, "thermo-", suggest *quantity* as well as property, due, no doubt, to the growing use of such terms as "thermal unit," "thermodynamics," *et cetera,* and when a little further investigation reveals that of the "hydro-" or "hydr-" and the "hygro-" or "hygr-" groups of words derived from the Greek the last-named is favored in connection with "moisture" rather than "water," it is only necessary to add the common terminant "ic" to form an adjective, *Thermohygric,* or "ics" to give name to the science itself. There seems no good reason why "thermohygrics" should not take a place with hydrodynamics, hydromechanics, hygrostatics, thermodynamics, electrokinetics, electrostatics, *et cetera,* as a convenient and useful designation for an important branch of science, or why the term, "thermohygric engineer" should not find use in displacing a whole string of ambiguous if not misleading adjectives.

*Air conditioning specialist. Member of Board of Consulting and Contributing Editors.



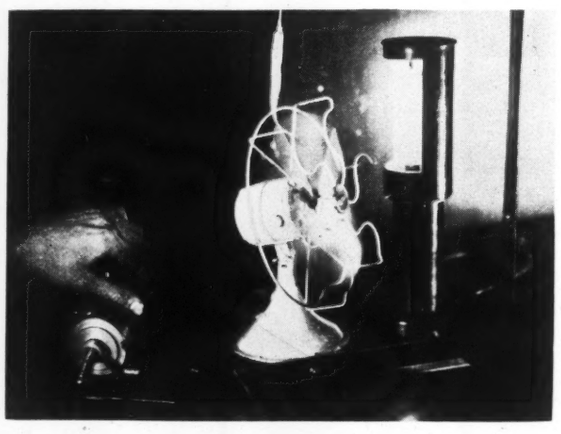
Moving fan and vortex of smoke at blade tip

Flow of Air Through a Fan

AN IMPORTANT application of the stroboscope which is not in general use is the study of the flow of air as it passes through the blades of a fan, according to Harold E. Edgerton of Massachusetts Institute of Technology in *Mechanical Engineering*[1]. The filaments of air are made visible by using smoke produced by titanium tetrachloride, $TiCl_4$, which reacts when exposed to air to give titanium dioxide, TiO_2. A convenient way to introduce the smoke into the air is to saturate a small wad of cloth or cotton with the liquid titanium tetrachloride, suspending the saturated wad on the end of a wire in the stream of air.

The observer sees the fan blades apparently going very slowly and the filaments of air passing slowly through their various phases of action.

One of the illustrations shows a mercury arc stroboscope arranged to illuminate an ordinary desk fan; the adjustable speed contactor is being adjusted so that the frequency of the light flashes and the speed of the fan correspond. The large illustration shows the moving fan and a vortex of smoke at the blade tip.



Mercury are stroboscope tube illuminating fan

[1] "Study of the Flow of Air with a Stroboscope," by Harold E. Edgerton, *Mechanical Engineering*, April, 1935. pp 228-229. Illustrations reproduced by permission.

This building is being modernized with a 300 ton air conditioning plant, a new heating system with automatic zone control

Modernize "Main Street"

A BILL passed by the Senate and House aims to raise the limit of modernization loans under the federal housing act from $2,000 to $50,000, would stimulate improvement of business property—"Main Street." "Main Street" in America comprises some 1,500,000 stores, shops, garages, offices, places of business of every kind. Though many have had the plans, few have remodelled, renovized, modernized during depression years.

Modernization of a place of business differs from home modernization in at least one important respect—dividends on the money spent are quickly apparent in increased sales, better occupancy, prevention of losses, many other ways. Probably air conditioning is most thought of right now when modernization of a store, shop, restaurant, office building or other business which must attract the public is considered. Improvement of the heating system is also a prime consideration, as many buildings have proved this a fruitful means of reducing cost of operation, improving service. (See "Modernization Number" of H. P. & A. C., January, 1933, and many subsequent articles[1].)

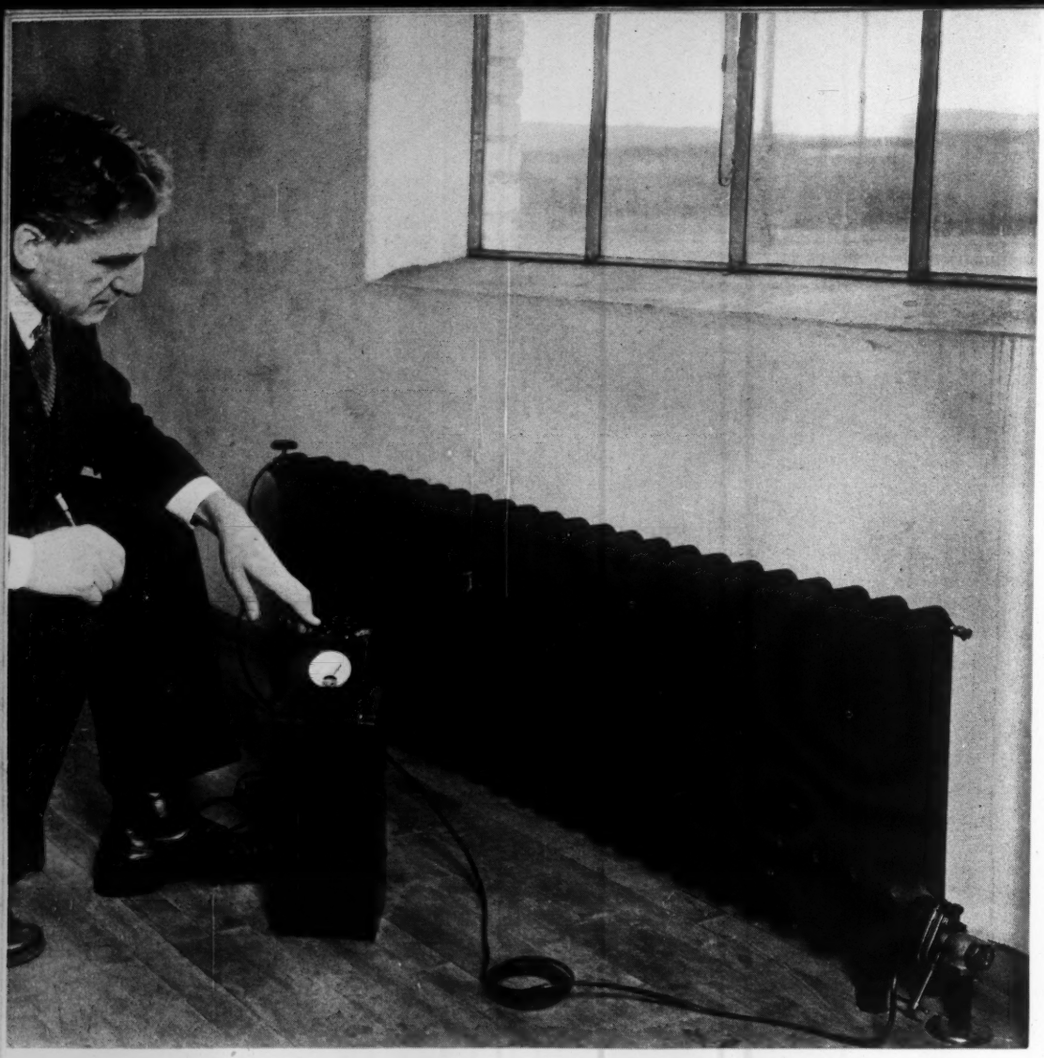
[1]Among them, "Unit-Type Air Conditioning System Modernizes Large Department Store," March, 1933; "17-Year Old Office Building Meets Competition by Air Conditioning," May, 1933; "Conditions Air For Six-Floor Tenant," September, 1933; "Control Reduces Steam Consumption 22 Per Cent," July, 1933; "$750 for Piping Change Cuts Fuel Bill $2,300," January, 1933; "Include in $3,300,000,000 Public Works Program the Modernization of Mechanical Equipment in Existing Properties," September, 1933; "Public Works Modernization—Get Consulting Engineers on the Job," October, 1933; "Suggests Recovery Act Funds be Used to Abate Smoke Nuisances," August, 1933; "Air Conditioning Pays Its Way in Candy Stores," March, 1934; "Consulting Engineer Surveys Theater Heating and Air Conditioning," December, 1934; "Grocery Store Ups Sales and Profits by Air Conditioning," October, 1934; "Modernizing with Air Conditioning," May, 1934; "One Air Conditioning System Leads to Another," June, 1934; "What's the Advantage of an Air Conditioned Office?" September, 1934; "Alert Management, Meters, and Proper Control Cut Building Heating Costs," July, 1934; "Heating Plant Check-Up Pays!" October, 1934; "Modernize Means Profit to Many Apartment Buildings," September, 1934; "Oil-Fired Central Boiler Plant Modernizes Heating Sytem for Five Apartment Buildings," May, 1934; "Plants and Buildings Modernize with Stokers," August, 1934; "Guests Like Comfort of Cooled Rooms, Detroit Statler Finds," January, 1935; "'What Air Conditioning Did for My Business,'" January, 1935; "Modernize Buildings for Health and Comfort as Well as Economy," February, 1935; "Revamping a Twenty-Year Old Heating System," March, 1935; "Cost of Heating Cut by Putting the Heat Where It's Needed," March, 1935; "Apartment Building Air Conditioning in Argentina," April, 1935.

Making loans up to $50,000 available for modernizing commercial buildings will stimulate nation-wide activity. Business men realize the advantages of and necessity for up-to-date buildings with up-to-date and modern equipment; in fact, numerous jobs (some planned months ago) are going forward right now.

Among them is the Insurance (office) Building, Omaha (see cut—note the sign featuring air conditioning). A year-'round, central station, 300 ton air conditioning plant is being installed, and a new heating system with automatic zone control is being put in. "Air conditioning is being installed," says Walter C. Johnson, head of Walter C. Johnson Co., "because of rental conditions. The building must be taken out of price competition and rented to the public strictly on the basis of quality."

Rentals, according to Mr. Johnson, may be directly attributed to the air conditioning and modernization of the structure. The Insurance Building is priced to give a fair return on the total invested capital and a uniform rental schedule is maintained. "Renting is progressing at a very satisfactory pace, even though we will not have our modernization completed until some time in July," stated Mr. Johnson.

Carson, Pirie, Scott (famous Chicago department store) is engaged in a large scale modernization program at the present time, featuring air conditioning of many areas, heating plant improvements, and other changes. Plans for the work have long been in development; the management feels that now is the time to go ahead. In Dallas, the Gulf State building is air conditioning all but two of 16 floors, the 2nd and 3rd floors to have central plants and all above the 4th to have room air conditioners. Practically three full floors of the Hotel Paxton, Omaha, will be air conditioned by the first of June. Many restaurants, stores, and shops will find business better this summer because of air conditioning.



[*The author equalizes a hot water radiator in a macaroni plant with his instrument.*]

Equalizing Hot Water Heating Systems

By Erwin L. Weber*

WITH hot water heating systems, a difficult problem has always been the equalization of the flow of water to each unit of radiation so that the total friction and resistance head in *any* circuit will equal the pressure head producing the flow of water within the same circuit.

This condition is achieved in a gravity system when the thermomotive force produced by the drop in temperature within each radiator exactly balances the friction head encountered in circulating the proper amount of water for that radiator in the circuit extending from the boiler, or heater, to that radiator and back. It is achieved in a purely forced circulating system (neglecting the "gravity component"[1]) when the pressure head produced by the pump, or circulator, exactly balances the friction head encountered in circulating the proper amount of water for that radiator in the circuit extending from the boiler, or heater, to that radiator and back.

A correctly balanced design involves many tedious calculations, as the complete circuit to each unit of radiation requires individual consideration. As we are limited to the use of commercial pipe sizes, it becomes necessary to introduce artificial resistances, such as orifices of various types, etc. An incorrectly balanced hot water heating system is of little more value than a watch which is not correctly balanced.

Many charts and tables (no two of which are alike) of pipe sizes, orifice sizes, etc, have been made to facilitate the calculations for hot water heating systems. The addition of a few extra fittings or any changes in runs during installation will invalidate the calculations and throw the design out of balance. The author's experience in testing the accuracy of equalization of such "precalculated" systems is that they are usually very far from balanced.

In forced circulation systems, the "gravity component" has a very marked influence in creating conditions of unbalance. This is especially noticeable where circulators which produce only a low pressure head are used, as here the "gravity component" produces a relatively greater effect than in systems which employ a pump with a high pressure head.

*Consulting Engineer, Seattle, Wash.

[1]Gravity component—that part of the pressure difference produced by the difference of density of the water in the supply and return piping because of the difference in temperature.

These considerations indicate that satisfactory conditions are best secured by using valves or other devices which can be externally regulated and set after the heating system is entirely completed and in operation.

An Instrument for Balancing Heating Systems

Many devices have been developed for balancing hot water heating systems, but there has remained the problem of equalization after installation. No rapid and commercial means was available of measuring the temperature drop through the radiators for the purpose of equalizing the valves or elbows.

For several years the author used thermocouples and a sensitive galvanometer for this purpose; the method of operation and the economies obtainable by a correctly balanced system were described in HEATING, PIPING AND AIR CONDITIONING, September 1932, p. 608. Recently, the author developed for his own use an electro-differential-thermometer, which is more sensitive and accurate, costs less and in addition can stand rougher usage. The meter is simple and fool-proof and can readily be used by the average workman.

Operation of the meter is based upon the change in the conductivity of metals with changes in temperature. One element is clamped to the union of the flow valve and another element is clamped to the union of the return elbow. Pushing the test key closes the various circuits of the network and the difference in temperature between the two elements is directly read upon the scale of the instrument to within 0.1 F. The meter is operated by two small pen-light-type dry cells. The full scale reading is 30 F; when higher drops in temperature are encountered, one of the cells can be short circuited, which doubles the readings and makes the full scale range 60 F.

In the normal (or open) position the test key disconnects the battery from the circuit so no current is consumed and it also short circuits the galvanometer, so that the needle will be dampened while transporting the instrument from radiator to radiator. A battery test key, which shows the condition of the battery and automatically tests the network, is also provided. Readings require from one to two minutes per radiator.

The author describes an instrument he has developed for equalizing hot water heating systems after installation. Through its use, flow through each unit of radiation may be accurately balanced to reduce fuel waste, promote heating efficiency. . . . In addition to describing the instrument, the need for equalization is pointed out and experiences with typical systems are discussed. . . . The same principle may also be employed in balancing brine cooling systems, and in rapidly locating leaky radiator traps on vacuum and vapor steam systems.

Importance of Equalization

Equalizing non-reflux elbows[2] and this method of equalization were used on a number of installations with the following results and experiences:—

The shops of the Seattle street and sewer department were heated with a gravity hot water system, which had never given satisfactory results. When the repair and maintenance of all city cars was placed in the hands of this department, a large amount of space which had been devoted to garage was converted to shop space. This required the addition of 33 new radiators and the relocation of many existing radiators. The old gravity system mains all were retained and many new branches and risers added. A circulating pump and zone control on the returns was installed and each radiator was provided with an equalizing non-reflux elbow. Despite the fact that the old gravity system mains were of quite improper pipe sizes for a forced circulating system, no trouble was experienced in securing a complete balance of the system.

In the macaroni factory of A. F. Ghiglione & Sons, Inc., a forced circulating hot water heating system with the equalizing elbows was installed. In balancing a hot water heating system it is desirable to perform the equalization at that water temperature which represents the *average* used during the heating season so that the effects of the "gravity component" produce the least disturbing results. As the plant was completed in the early fall and the owners did not wish to run at a high temperature because of the process work under way, equalization was deferred several weeks awaiting colder weather. In the meantime the system was temporarily equalized by the usual method of feeling the flow and return branches to the radiators with the hands.

During the final test and equalization, it was noted that whenever the circulating pump was stopped, the check discs in the equalizing elbows clicked in succession along the entire circuit. This indicated that a surge of water was taking place. Inspection showed that the expansion line had been connected to the discharge line in place of the suction line of the pump, thus raising the water level in the expansion tank, causing loss of water through the overflow line and in addition causing the upper part of many of the radiators to be filled with vapor due to the partial vacuum there produced. But for the clicks produced by the discs this undesirable and wasteful condition might never have been found, as the operating engineer considered these noises merely an integral part of any heating system.

Before equalization, the drops in temperature through the radiators were found to vary from 4 F to 28 F. These differences in the drop in temperature *could not be detected* by the usual method of feeling the flow and return branches to the radiators with the hands, but were readily detected by the meter. After equalization the drops in temperature were all brought to within one degree of 10 F.

The economic value of proper equalization cannot be over emphasized, when we consider the waste of

[2]Described by the author in HEATING, PIPING AND AIR CONDITIONING, November 1932, p. 748.

fuel resulting from its neglect. In the installation cited (analyzed before equalization) the average temperature of the hot water during the heating season would be 150 F (flow, 155 F; return 145 F). To bring the radiators with a drop of 28 F to an average temperature of 150 F requires a flow temperature of 164 F and a return temperature of 136 F. It would therefore be necessary to carry a flow temperature of 164 F on the entire system to compensate for the diminished circulation through some of the radiators, and the mean temperature of the average of the balance of the radiators would be raised to 164—6 or 158 F instead of 150 F.

The heat emission would then be in the ratio of the emissions at these two temperatures, or 0.523/0.462 = 1.132. (See *A.S.H.V.E. Guide* 1932 p. 98). This shows over 13 per cent waste of fuel.

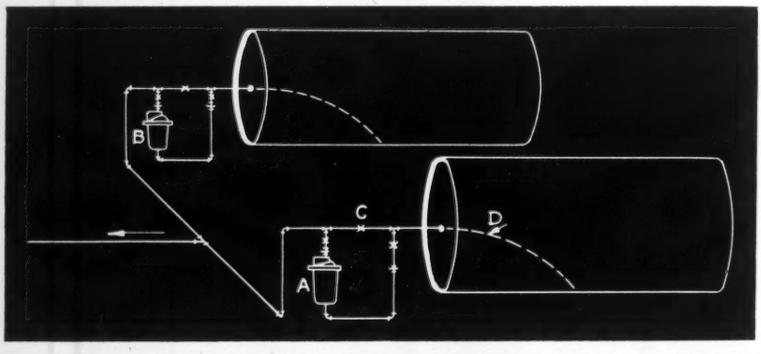
Such a loss in the usual type of building having radiators averaging 50 sq ft each and costing 30c per sq ft per annum in fuel, or $15.00 per radiator, amounts to $1.95 per radiator per season, which during a 30 year life of the building runs up to $58.50 per radiator. The loss due to improper equalization consequently represents real money.

Principle Used for Balancing Brine Systems; Locating Leaky Radiator Traps

The meter developed for equalizing hot water heating systems also can be used for balancing brine cooling systems. As the coils in such systems often are of great length, with considerable distance between the supply valve and the return elbow, the meter is designed so that the leads to the elements may be of any desired length, without affecting accuracy of the readings.

Another use of the instrument is to locate leaky radiator traps in vacuum and vapor steam systems rapidly. It is merely necessary to clamp one element to the union of the steam valve and the other element to the outlet of the trap. A high drop in temperature indicates a steam-tight trap, whereas a low drop in temperature indicates a leaky trap.

Don't Jump at Conclusions *when* Looking for Trap Trouble



These two steam traps drain the steam heated rolls of a dry milk machine. Trap "A" won't work when the bypass valve "C" is closed; four out of five would blame the trap. But the real trouble is a leak in the syphon pipe at point "D"—proving that jumping at conclusions when trouble-shooting is risky business

By* T. H. Rea

JUMPING at conclusions when trouble-shooting may prove as risky as excessive pride in a pair of aces when playing poker with the deuces wild.

For example, the sketch shows two identical steam traps used to drain the steam heated rolls of a dry milk machine. Both traps have orifices suitable for operation at a maximum of 100 lb pressure; actual working steam pressure is 80 lb. Both drying rolls have syphon pipes for picking up the condensate.

Trap "B" works perfectly. Trap "A," however, will not operate as long as bypass valve "C" is closed. Crack valve "C" and the trap immediately starts to work. Then shut valve "C." The trap at once closes and stays closed.

Four out of five operators would blame the trap. They reason that the trap will not open at the working pressure and that cracking the valve drops the pressure to the point where the trap can operate. Their reasoning is correct in that opening the bypass valve does decrease the pressure in the line to the trap. But their conclusion is wrong because the trap will actually open at 100 lb pressure. Dropping the pressure from 80 to 78 lb does not of itself allow the trap to open.

The reason the trap refuses to operate when the bypass valve is closed is because there is a leak in the syphon pipe. (Point "D" on the diagram). Water will not rise in the syphon pipe unless the pressure in the line to the trap is less than the pressure in the dryer. A leak in the syphon pipe equalizes the pressure so condensate remains in the bottom of the dryer. Hence, no water gets to the trap and the trap does not open.

Cracking the bypass valve bleeds off steam faster than it can enter the syphon pipe through the leak. The line pressure, therefore, drops allowing condensate to syphon over to the trap. Of course, the trap goes to work as soon as it has something to do.

*Armstrong Machine Works, Three Rivers, Mich.

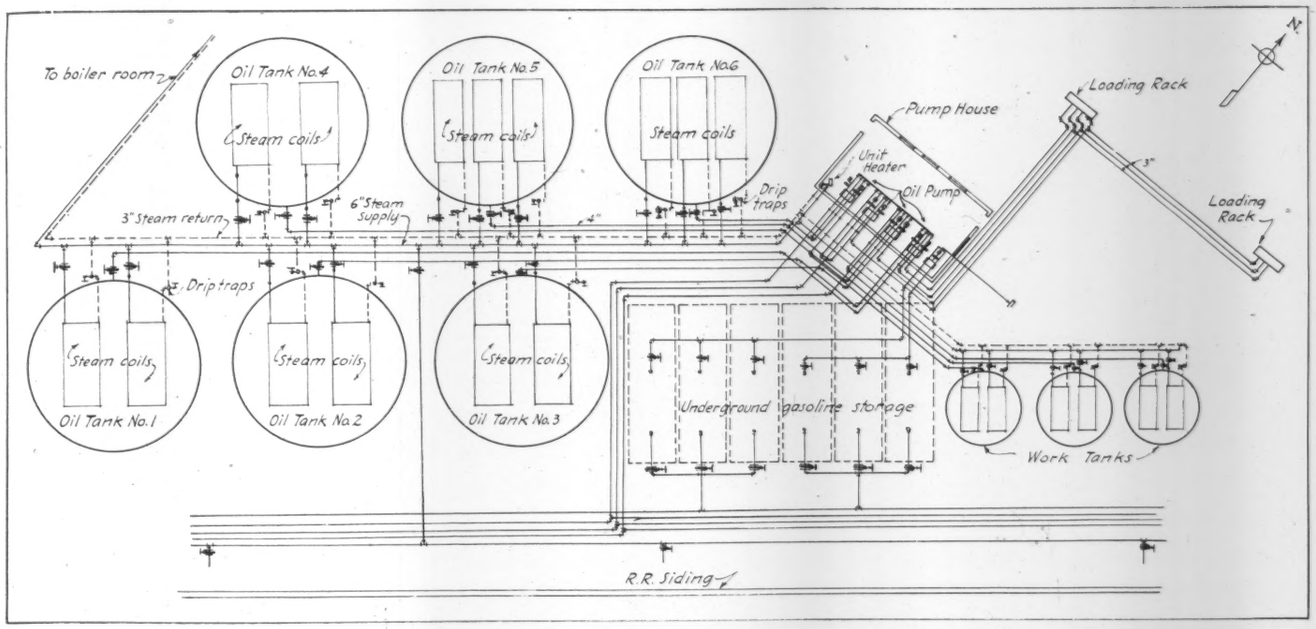


Fig. 1—Plan showing location and arrangement of piping and tanks

Design and Erection of a Bulk Fuel Oil Storage Plant †

By **Kalman Steiner***

PIPING and heating present the major problems in the design of a bulk storage plant for liquid fuels. However, as a preliminary consideration, a few words on the selection of the site will not be amiss. There are but a few factors which enter into a decision.

Since one of the major expenses of operation for a distributor of fuel oil or gasoline is the cost of hauling, or deliveries to customers via tank truck, a central location is imperative to reasonable trucking costs. Of course a location at the geographic center of a municipality is usually neither feasible nor necessary, but in the selection of location it is well to avoid the outskirts or suburbs of a large city, assuming that a truck fleet is to use this plant as a base for covering the entire city. And since it is reasonable to expect that business density will in general determine the direction of the heavier shipments, a location just outside the city's principal business district is ideally suitable. Such a site will also avoid the higher realty values.

Economy in handling fuel oil and gasoline in a bulk storage plant depends upon proper layout of the various components of the plant, the interconnecting piping, and the pumping equipment. The author discusses here selection of the site, determination of the required storage capacity, structural considerations, plant layout, and tank design, using a recently completed plant as an example. A future discussion will cover in detail design of piping, pumping equipment, and the heating of the oil and of the buildings.

Next in importance to trucking costs as affecting site location is the matter of railroad facilities. For the Chicago district, for instance, there are two prime objectives to attain as regards railroad connections: A direct main line road should serve the plant from the southwest oil well areas, and a belt line must also offer service from the East Chicago—Whiting refinery area. A third consideration—still minor but which may attain for more importance in the next five or ten years—is a waterway dockage. In the relatively near future we may see large quantities of petroleum products entering the Chicago market via an inland water route.

It has been mentioned that avoidance of residential districts will hold down land values. Another reason for seeking industrial areas for a bulk plant location is that the legal requirements are more easily conformed with, and the frontage consents of adjoining property owners more easily secured. It is obvious that since a bulk plant is not inherently a thing of beauty (despite the fact that it may represent the culmination of careful planning, sound engineering, good construction, and considerable investment) it might be held by those concerned that the neighborhood's loveliness is not enhanced by such an addition. The final requirement to decision on location is that the necessary municipal permits be issued covering the contemplated storage tanks.

*Chief Engineer, Consumers Petroleum Co., Chicago, Ill.
†Copyright, 1935, by Kalman Steiner.

Determination of Storage Capacity

The number, size, and type of tanks must be carefully determined, and several factors must be weighed. Such variables as total yearly volume handled, ratio of daily shipment to daily receipts of material, advantages of summer prices on purchases, amount of liquid being held warm in storage for loading of trucks in winter weather, number of different liquids stored and handled, necessity for blending, reserves of material for possible freight embargoes or strikes, etc., all have their bearing. In general, the minimum storage for safe and economical operation of this type of business is the equivalent of the total gallonage shipped out during two weeks of the peak season. For fuel oil, this would be roughly 1/15 of a year's total, where the fuel is largely used in heating plants. Since large consumers of fuel oil for other than heating purposes generally purchase their requirements in tank car quantities, it is usually found that about 80 per cent of the fuel oil delivered via tank truck is burned under heating boilers. Hence, a firm having an annual business of 10,000,000 gallons should have not less than 650,000 gallons storage.

From a minimum of 1/15, it is economical to increase storage facilities up to 1/5 of a year's total volume. Beyond this, additional storage is economical only if oil shipments are received by barge-load. Otherwise the investment and overhead charges are likely to exceed the economies.

From the amount of storage capacity to be erected, and the distribution of the year's total sales into the several different liquids handled, by percentage of total, it is possible to compute the amount of storage to be alloted to each grade or kind of fuel. This gives the size of the tanks to be provided for general storage.

After these main tanks have thus been worked out, there remains the problem of sizing the smaller, or working, tanks which are provided with large capacity heating coils to permit quick heating to high temperatures. These tanks are filled from the main bulk tanks, and the fuel is pumped into trucks for delivery from the working tanks.

Working tanks are important, for if the main tanks and their contents are held at temperatures sufficiently high for direct loading, a heavy radiation loss results. If, however, the oil in bulk tanks is maintained just above the cold test temperature, then only that oil in the work tank need be heated to higher temperatures, and the radiation loss is greatly reduced. Usually a work tank need be only large enough to hold a day's supply. A convenient routine for plant procedure is to fill these tanks during the night, with the heating coils turned on full. By morning an ample supply of hot oil is available. Most plants of this type will load up the whole fleet of trucks for the first loads each morning. Immediately thereafter, the work tanks can be filled again, and then the rest of the day's loadings is easily made from these.

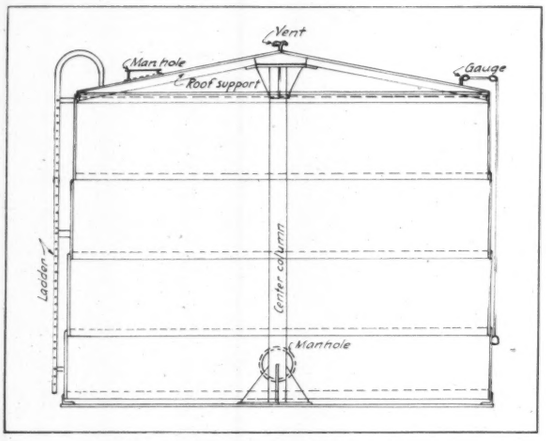


Fig. 2—Detail of tank structure

After the tank sizes have been worked out, attention to the preliminary structural problems is necessary. As most fuel oil tanks are vertical cylinders above ground and as each foot of tank height means a load of about 60 lb per sq ft, and since 30 ft is not an uncommon height for such tanks, it becomes apparent that the soil may be stressed by a load of 1800 lb per sq ft or more. This is not a dangerous load for solid earth, but if the particular site chosen is likely to be filled-in land, or the grade of which has been raised by dumping of loose earth or refuse, then it is essential that a test drilling be made to a fair depth so that accurate knowledge of the soil bearing capacity may be had. On solid ground no piling or concrete footings will be needed; if the ground is marshy, or has been filled-in, then of course adequate foundations are needed. The matter then becomes a problem in civil engineering, and need not be further discussed here. We shall proceed on the basis of there being solid ground for the tanks.

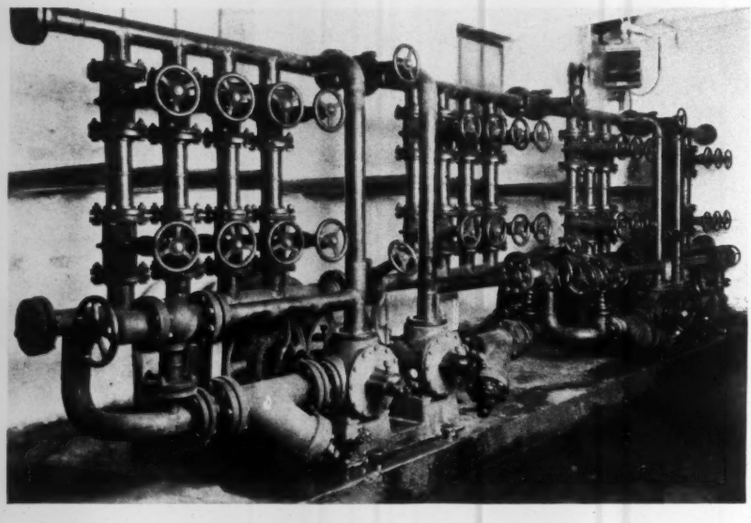


Fig. 3—Valve header and pumps

It happens that the severest stresses set up in the metal shell of vertical storage tanks occur in that portion where observation of the resultant strain is impossible—the tank bottom. In rhythm with the rise and fall in depth of the liquid it supports, the tank bottom breathes; that is, its contour changes by the alternation of its concavities and convexities. Structural limitations preclude so massive a bottom that a plane surface could be maintained despite changes of load. Hence, the

foundation supporting the tank bottom must be adapted to this changing contour of the steel sheets which compose the under surface of the tank.

An excellent bed for support of the tank bottom can be built up from crushed limestone, the bed ranging from coarse lumps on bottom to fine sand on top, through a total thickness of two feet. The surface of this bed should be sprayed with road oil before the steel plates are permanently set. This acts as a binder for the finer particles, and together with a similar coating placed on the steel after the plates have been painted with red lead, serves to inhibit oxidation of the metal. The porous nature of this foundation also assures quick draining of rain water, so that rusting of the tank bottom is quite unlikely. A foundation of this kind is better than a solid concrete base, for a concrete slab is nonresilient and unable to assist the steel plates in meeting the stresses to which they are constantly being subjected.

Fig. 4—Piping between tanks and pump house

Layout of the Plant

At this point it will be well to abandon temporarily our discussion of tank construction for the purpose of viewing a bulk plant as a whole. It should be a smoothly working entity where the several departments function as complements to each other. The flow of materials and sequence of operations must be logical and in proper conformance each to the other. The component units of the plant are executive and general offices, plant operating office, testing laboratory, boiler house, pump house, railroad siding, storage tanks, loading racks, oil piping, and steam and condensate piping.

Fig. 1 shows that three separate buildings were used to house those units and departments which are under roof in the particular plant under consideration. The main building houses the executive, engineering, sales and general offices. Because of its distance from the boiler house, this building is not heated from the main boiler plant, but instead has a small oil-fired boiler in the boiler room. A second building houses the plant superintendent's office, truck drivers' quarters, boiler plant, laboratory and machine shop. The third building shelters the pumping equipment. Provision has been made for the future erection of a garage adjoining the superintendent's office.

Storage Tank Design

Each of the six main tanks in the plant has a capacity of 100,400 gallons, or 2400 barrels; overall dimensions are 28½ ft diameter by 21 ft in height of the vertical walls. Liquid is not usually taken up into the conical roof. It can be readily established by the principles of maxima and minima of differential calculus that for a cylindrical vessel, greatest content is obtained with least amount of enclosing surface when the diameter equals the height of the cylinder. Therefore the most economical tank to build from the viewpoint of minimum steel plate required and hence of original cost, is one which conforms to this rule. It might be thought at first glance that a low, wide tank would minimize pumping cost because of the lower hydrostatic head to be overcome when filling. But of course it is equally true that the increased hydrostatic head attained when filling a taller tank will in the reverse pumping operation—loading of trucks—exert an equal economy of power at that time.

The thickness required for the walls of the tank, insofar as stress due to hydrostatic pressure is concerned, is readily obtained by:

$$t = \frac{0.434\ H\ D}{2\ s}$$

where

t = thickness of metal, in.
H = height of tank, ft.
D = diameter of tank, in.
s = allowable working stress, lb per sq in.

For the dimensions stated above for these tanks, and allowing a working stress of 12,000 lb per sq in., the required thickness of plate is 0.13 in. Actually, to assure a firm welding joint and as additional reserve against possible internal pressures built up by rapid pumping of oil into the tanks against slower venting, the plate thickness used was ¼ in. A similar calculation could be made for the bending stress set up in the bottom, and again it would be found that the theoretical thickness is much less than the ¼ in. actually used.

Fig. 2 is a detail of the tank structure. After the bottom has been formed, an angle iron ring is welded around its complete circumference. To this is bolted the first section of wall plates. When the entire first circular section is bolted in place, the bottom seam and vertical seams between plates are welded, and the bolt ends are welded into the plates. Then the plates of the next horizontal section are raised and bolted into place, and the welding continued.

Fig. 2 also indicates the center column and roof supporting beams. Although the tank walls, being formed of ¼ in. steel plate shaped into a cylinder, could easily stand without other support, the tank roof must have a framework to hold it independently of the walls, and thus a center column is needed. A few

members are therefore taken off from this center colum to give additional strength to the entire structure.

The tank roof carries most of the required outlets: manholes, vents, gauge opening, etc. The tank walls carry the remaining openings: Suction and discharge connections, drains, etc. There are no openings of any kind in the tank bottom.

Gasoline Tanks—Gasoline storage tanks in distributing plants such as these are usually underground for safety and because of legal requirements. This plant has a battery of ten 13,000 gallon horizontal tanks. These tanks were taken from standard railroad tank cars which had been withdrawn from service. The tanks themselves were perfectly sound, and were subjected to a pressure test of 20 lb per sq in. before being accepted. The railroad car domes were cut down to a few inches in height to give the equivalent of a standard manhole.

The Pumps and Piping

The pumps and piping in a bulk storage plant must be designed as a flexible system, for they must serve numerous purposes. Fig. 1 shows that the following pumping operations must be and can be accomplished through a single battery of pumps and a valve nest with header:

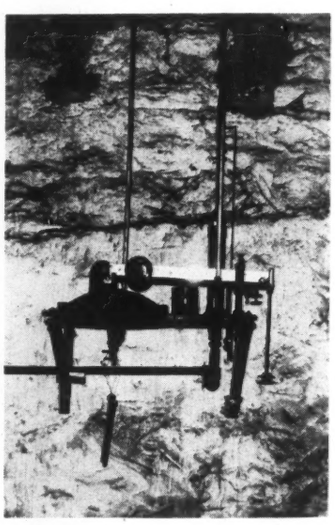
1. Fuel oil can be unloaded through the bottom car connection and pumped into any of the six bulk tanks, or any of the three work tanks.
2. Fuel oil can be pumped from any of the six bulk tanks or three work tanks up to either of the two truck loading racks.
3. Fuel oil can be pumped from any one of the nine tanks into any of the other eight tanks.
4. Fuel oil can be pumped from any of the nine tanks up into the cars on railroad siding.
5. It is possible to handle six grades of oil and to keep them segregated in handling by confining any two grades to a single piping and pumping system. This avoids mixing of liquids or contamination in the lines when operations are switched from one grade to another.
6. It is possible to unload four tank cars simultaneously, handling either one, two, or three different materials.
7. It is possible to load four trucks simultaneously, handling from one to four different materials.
8. Gasoline is handled by a completely separate set of equipment, from tank cars into tanks, and from tanks into trucks.

Fig. 3 shows the valve header and pumps and Fig. 4 shows the piping converging to pump house from siding and tanks. This view also illustrates the method of making connections into tanks from oil lines, as well as the steam and condensate connections to the tank heater coils.

[The second part of this article will discuss the design of the pumping equipment, determination of piping sizes, design and installation of the heating coils in the tanks, the boiler plant, and the heating of the buildings.—The Editor.]

Diaphragm Valve is Dropped for Better Heating Control

By **H. G. Schaefer**



Sensitivity of this pilot valve was increased by dropping it to increase the static head on the membrane, compensating for the increase by adjustment of the counterweight

IN the constant endeavor to improve heating plant efficiency, the operator often finds it necessary to regulate steam pressure down to ounces rather than pounds. The difference between a pound of pressure carried in the system against the 12 ounces that may suffice for a particular load frequently affects the fuel bill appreciably.

Refinement of control often can be gained without a major change in equipment; the valve illustrated here is an example.

When we push the button of the common electric door-bell, most of the force applied is required to overcome the resistance of the spring. If the total travel of the button is $\frac{3}{16}$ in., only the last few thousandths do the actual work of establishing the circuit. By taking up the spring tension so that the contacts are just sufficiently removed from each other to break the circuit, the push button will be made highly sensitive.

Similarly, most of the energy required to flex the diaphragm of a regulator is required to overcome the internal stresses that tend to maintain the normal shape of the rubber and fibre, or metal, membrane. If these forces can be almost exactly compensated by a fixed counter-force, comparable to the taking up of the spring tension in the sensitively adjusted push button, any variation in the controlling pressure will immediately register in the output of the unit, making it more sensitive.

The mechanical strength of the diaphragm of the pilot valve illustrated caused its reaction to slight pressure changes to be extremely sluggish and uncertain. The operating engineer therefore dropped the unit 4 ft in order to increase the static head on the membrane surface, compensating for the increase by counterweight adjustment. After several preliminary settings, made with hose connections, the point at which the mechanical resistance of the unit was minimized by the working back pressure augmented by the water leg, was determined. In this particular case, manometer readings measured the performance.

The result was much greater sensitivity.

Heating·Piping
and Air Conditioning

American Society of Heating and Ventilating Engineers JOURNAL SECTION

MAY 1935

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Classroom Odors With Reduced Outside Air Supply

By **F. C. Houghten* *(MEMBER)*, H. H. Trimble,* * Carl Gutberlet,*** and Merle F. Lichtenfels,†*(NON-MEMBERS)***

Pittsburgh, Pa.

AIR volume requirements for school house ventilation probably have been the subject of more controversy than any other phase of heating and ventilation. The engineer, the medical man, the educator, and the school business management have all had their part in the developments. The wide diversity of opinion more or less accepted by various groups at different times is indicated by the lack of unanimity in the legal requirements on the statute books of several States. These requirements vary from 30 cu ft of outside air per minute per pupil, downward.

At times, the engineer and members of the medical profession have seemed to be far apart in their positions on this controversy. The engineer approaching the subject from the practical demands of school ventilation requirements knew that he could not maintain acceptable conditions within the school room without handling a large volume of air through the prevailing ventilating system in the classroom of conventional size and pupil density. Thus convinced, he naturally sought for and accepted diverse theoretical reasons to support what he found to be necessary. The representative of the medical profession, on the other hand, approaching the subject from his theoretical knowledge concerning the oxygen requirements and the lack of harmfulness of carbon dioxide, was unable to recognize a need for more than a very nominal amount of outside air.

The past decade and a half have witnessed the development through research of a more complete understanding of the processes of metabolism and thermal exchange between the human body and its atmospheric environment, including the effect of the temperature, humidity and motion of the air on a person's feeling of warmth and the necessity for a reasonably high air movement within the occupied space (as measured by the Kata thermometer) in order to insure the distribution of air having the proper physical qualities over the body itself. These developments have resulted in complete vindication of the engineer's position regarding the circulation of a relatively large volume of air in the conventional classroom. It has developed, however, that the recirculation of air within the classroom is as effective in providing the required motion and cooling power of the air as the supplying of outside air, provided the proper effective temperature of the recirculated air is maintained.

This later development has reopened the controversy concerning the required amount of outside air. If recirculated air is as effective as outside air in producing the desired cooling power of the air, why should an outside air supply greater than that necessary to supply the minimum requirements for oxygen supply and carbon dioxide elimination be required? Although recently challenged by some authorities, it seems to be

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generally agreed that the requirement of outside air for oxygen supply and carbon dioxide elimination is no greater than from 2 to 4 cfm per person, which in conventional classrooms will usually be supplied by infiltration and the initial volume of air in the room before occupancy. Based upon this reasoning, it seems logical to contend that no outside air need be supplied through the ventilating system, except when required to maintain the desired cooling power of the air. Recent research aimed to establish a more rational basis for outside air requirements in school ventilation has indicated that when outside air is not required to maintain the cooling power, odors represent a limiting factor. Lehmberg and others[1] have recently shown that in a small confined space, odors become objectionable when the air supply drops to, from 10 to 25 cfm per person.

The Research Laboratory of the American Society of Heating and Ventilating Engineers has recently been engaged in a study of the relation of air delivery in a classroom to drafts. In connection with this study, facilities were found available for obtaining first-hand practical information on the relation between air delivery to a classroom and such effects as overheating, change in moisture content, increase in CO_2 content, and prevalence of odors.

The study was made in classrooms of the Woodlawn Avenue School of Munhall, Pennsylvania, a steel mill suburb of Pittsburgh. The Woodlawn Avenue School includes pupils of the 7th, 8th, 9th and 10th grades, from the better class residential sections of the town, farthest removed from the mill district.

The results presented in this paper are based on three half-day studies and several additional observations made in classrooms normally occupied by classes. Study Number One was made in a first-floor classroom on a day when the outside temperature ranged from 10 F at 8:00 a.m., to 14 F at noon. A cold day was chosen with the expectation that overheating would not result from reduction in outside air supply. The particular room studied was chosen for the reason that, because of the prevalence of cold drafts, the teacher was unusually amiable toward the study, even though the observations made might be somewhat disturbing to her work.

This room had a 28 ft eastern exposure containing approximately 36 per cent glass. It was 22 ft wide and had a 12 ft ceiling. The lower half of the windows opened on a central horizontal pivot. The movable sections were weatherstripped and locked firmly in place so as to allow little opportunity for air leakage when closed. The room was equipped with a unit ventilator controlled from the janitor's quarters in the basement either to take in all outside air or to recirculate room air. This unit was equipped with a heating unit supplied with steam without either automatic or convenient hand control. A thermostatic controlled damper directed the air either through the heater or around it. The room was also equipped with one auxiliary, cast-iron direct radiator located along the exposed wall, and supplied with steam under thermostatic control. The control of the bypass damper in the unit ventilator and of the steam supply to the auxiliary radiators was had by a dual thermostat designed first to cut off the steam supply to the direct radiator as the temperature rose through the desired point, and then if this did not arrest the rise in temperature, to open the bypass damper in the unit ventilator. In this room the unit ventilator was located under a window in the center of the front third of the room, or near the teacher's desk. The vent stack was 20 in. by 30 in. in cross-section, with a 20 in. by 38 in. opening immediately above the floor line in the rear of the room.

Before the arrival of the children on the morning of the study, changes were made so that the steam supply to the auxiliary radiator could be controlled by hand. The central control of the outside air intake and of the recirculating dampers was disconnected, the intake damper was fastened securely in the closed position, and the recirculating damper in the open position, and the steam supply was shut off from the heater in the unit ventilator. The vent flue opening was closed.

The unit ventilator was allowed to operate at the usual rate of air circulation, and an attempt was made to maintain a room temperature of 70 F by hand control of the steam to the auxiliary radiator, beginning at 8:30 a.m., or one-half hour before the beginning of the first class period.

A Haldane gas analyzing machine was set up in the center of the room, with which samples of the air were taken and analyzed continuously from 8:30 a.m. until 12:00 noon. Another observer recorded the dry-bulb and wet-bulb temperatures and other conditions in the room, besides making the desired adjustments to the heat supply. There was a 6 to 10 mph, NW wind during this study. The occupants of the room had an average body surface area of 15.2 sq ft. The results of this study are plotted in Fig. 1.

The second study was made in a room on the opposite side and on the third or top floor of the building, having an exposed wall 32 ft long, containing approximately

[1] A Laboratory Study of Minimum Ventilation Requirements: Ventilation Box Experiments, by W. H. Lehmberg, A. D. Brandt, and Kenneth Morse. A.S.H.V.E. Journal Section *(Heating, Piping and Air Conditioning)*, January 1935, p. 44.

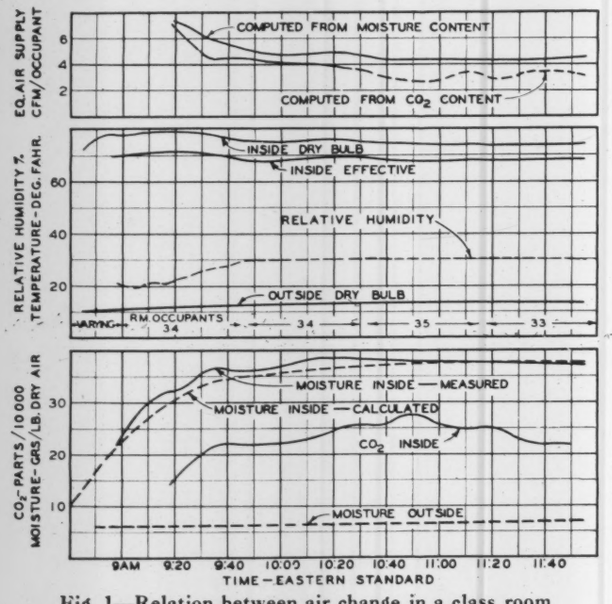

Fig. 1—Relation between air change in a class room and occupancy. CO_2 production and increase in moisture content. No positive air supply. Overheating from solar radiation and boiler plant

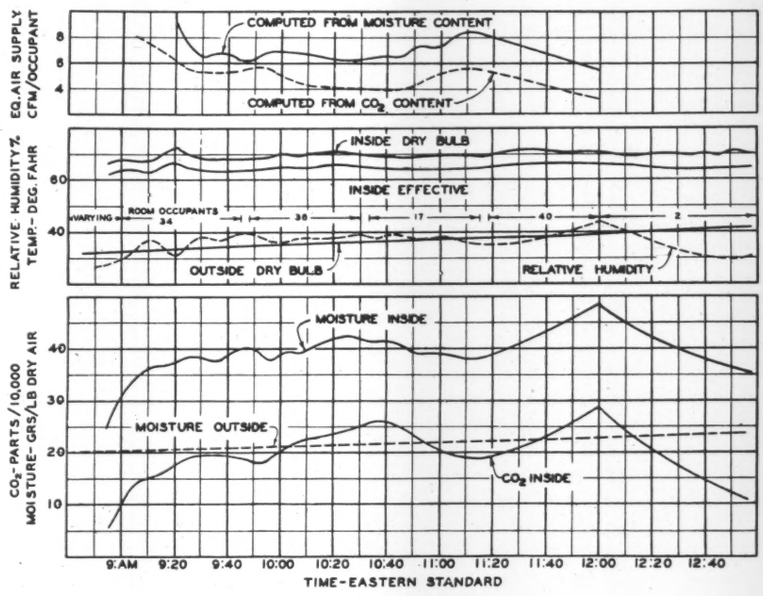

Fig. 2—Relation between air change in a class room and occupancy. CO_2 production and increase in moisture content. No positive air supply. No solar radiation

35 per cent glass. This room was 22 ft wide, and was also heated by a unit ventilator and two auxiliary direct, cast-iron radiators, with the same control as that described for the room in which the first study was made. The unit ventilator in this room was located in the center of the exposed wall, with an auxiliary radiator on each side. The room was vented by a 20 in. by 20 in. stack, having a 20 in. by 38 in. opening immediately above the floor line in the rear of the room which was left open throughout the study. There was a 10 to 12 mph, SW wind during this study. The occupants of the room had an average body surface area of 17.2 sq ft. This study was conducted in a manner similar to the first study described above, and the results are plotted in Fig. 2.

The third study was made in a room of the same dimensions and equipped with a unit ventilator and two auxiliary radiators having approximately the same location, size and arrangement as the room in which the second study was made. The preparation for and the operation of this study was similar to that of the first two, excepting that at 10:35 a.m., or after the elapse of approximately one-half of the forenoon period, the intake damper was partially opened so as to supply a small volume of outside air. There was a 10 to 12 mph, SW wind during this study. The occupants of the room had an average body surface area of 17.2 sq ft. The results of this study are plotted in Fig. 3.

The pre-arranged conditions under which the three studies were made did not result in as wide a range of air change rates as anticipated. It was hoped that opening the intake damper during the third study would give an air change as high as 15 cfm per person, in order to give an opportunity to observe conditions with air changes ranging from 10 to 15 cfm per person. In order to give data in this range, four extra observations were made in rooms when the normal air change rates were cut down somewhat.

Analysis and Discussion of Results of Studies

The CO_2 and water vapor content of the air in an occupied room vary according to a rather complicated relationship between the rate of outside air supply (either positive supply or infiltration) and its CO_2 and water vapor content, the volume of the room under question and the CO_2 and water vapor content of the air contained therein at the beginning of the time considered, and the rates at which CO_2 and water vapor are added to the atmosphere in the room by the occupants. The volume in cubic feet of CO_2 and water vapor contained in the room at any time t minutes after the beginning of the time considered is given by Q in the dilution formula:[2]

$$Q = \frac{V_r}{V_v} V_{gas} \left(1 - e^{-\frac{V_v}{V_r} t} \right) + Q_o e^{-\frac{V_v}{V_r} t}$$

where:

V_r = volume of room in cu ft.
V_v = volume of air supplied in cfm.
V_{gas} = volume, in cu ft, of carbon dioxide or water vapor added to the room per minute.
Q_o = volume, in cu ft, of carbon dioxide or water vapor in the room at the beginning of the time considered, or when $t = 0$.
e = base of the Naperian system of logarithms, 2.71828.

[2]Carbon Monoxide Distribution in Relation to the Ventilation of an Underground Ramp Garage, by F. C. Houghten and Paul McDermott. A.S.H.V.E. TRANSACTIONS, Vol. 38, 1932, p. 439.

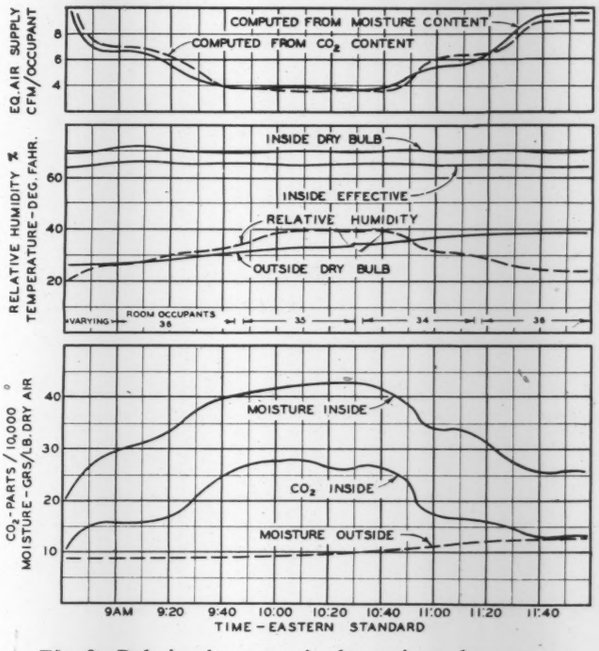

Fig. 3—Relation between air change in a class room and occupancy. CO_2 production and increase in moisture content. Positive air supply. No solar radiation

This formula applies either while the concentration within the room is being built up or while it is being diluted.

If the volume of the air contained in the room at the beginning of the time considered may be neglected, the relationship between the ventilation rate and the rate of production of CO_2 or water vapor in the room becomes much more simple. The ventilation rate in cfm per occupant is then given by the following formulæ which apply after equilibrium has been reached:

$$R = \frac{C \times \frac{S}{19.5}}{P \times 10^{-4}}$$

where:

R = ventilation rate in cfm per occupant (standard conditions).
C = CO_2 production rate, in cfm per average sized man of 19.5 sq ft (standard conditions).
S = area of average subject, in sq ft.
P = increase in CO_2 concentration, in parts per 10,000.

or,

$$R = \frac{M \times \frac{S}{19.5}}{G \times w}$$

where:

R = ventilation rate in cfm per occupant (standard conditions).
M = moisture production rate in grains per minute per average sized man of 19.5 sq ft (standard conditions).
S = area of average subject, in sq ft.
G = increase in moisture content in grains per lb of dry air as actually determined from wet and dry-bulb readings and psychrometric chart.
w = weight of air in lb per cu ft (standard conditions).

If equilibrium has not been reached, the application of these formulae to the conditions in the enclosed room will give a theoretical ventilation rate which would, after the elapse of infinite time, give precisely the same conditions. Hence, the application of these formulae gives an equivalent rate of air supply. They were used in calculating the "equivalent air supply in cubic feet per minute per occupant" plotted in the upper part of Figs. 1, 2 and 3. The equivalent air change rate based upon CO_2 was computed from: the CO_2 concentration observed in the room and plotted in the lower part of the charts, a CO_2 content in the incoming air of three parts in 10,000, and a rate of CO_2 production per occupant equal to 0.00983 cfm for an average sized man having a body surface area of 19.5 (as found in an earlier laboratory study)[3], and the average surface area of the occupants of the rooms as computed from the school records for the different class periods studied.

The equivalent air supply as plotted in the upper part of the charts, "Computed from the moisture content," was based on a moisture content of the incoming air equal to that found in the outside atmosphere during the period of the study, and the moisture content of the air in the rooms during the studies. In calculating the air change from the moisture content, care must be observed in assuming the proper rate of moisture dissipation from the body, based upon the body surface area of the occupants and the dry-bulb temperature of the air in accordance with earlier laboratory studies[3]. In this earlier study, it may be of interest to note that an average sized man, having a body surface area of 19.5 sq ft, gives off 11.5 grains of moisture per minute in an atmosphere with a dry-bulb temperature of 70 F, 14.6 grains when the temperature was 75 F, and 18.0 grains per minute when the temperature was 78 F.

The actual equivalent air change per room, based upon the above assumption, is given by the equivalent air supply per occupant as plotted in the upper part of the chart, multiplied by the number of occupants indicated in the middle part of the charts. For most conditions when the occupancy of the room had been constant for a considerable length of time so that equilibrium was approached, air changes ranging from 1 to 1½ per hour were indicated. In the second study all of the occupants with the exception of one observer left the room promptly at noon. The room was then closed and analyses of the CO_2 in the air and other observations were continued for the following hour while the concentration of CO_2 and water vapor decreased due to dilution. The application of the dilution formula given above to this part of the CO_2 curve gives an air change of 1.2 per hour for the room, which is in close agreement with a change of 1.18 based upon an average equivalent air supply during the last hour before noon of 4.24 cfm per person, and a room occupancy of 40 persons.

It will be observed that the equivalent air supply calculated from the CO_2 and moisture content within the room never agreed, although the disagreement is not great in the first or third studies. This disagreement is probably accounted for by dehumidification of the atmosphere within the room, either by condensation on cold surfaces or moisture absorption by other surfaces. In the first study there was a small amount of moisture condensation on the windows, and in the second study there was considerable condensation. During the time when the moisture content in the third study was highest a small amount of condensation appeared on the windows, which disappeared quickly after the rate of air supply was increased by opening the intake damper at 10:35 a.m. Undoubtedly, the reversal in the equivalent air supply indicated between 10:50 and 11:20 a.m. during this study is accounted for by re-evaporation. In applying the dilution formula to the air change within the room, based upon the diminishing content of water vapor after 12:00 in the second study, an air change of 0.91 per hour is indicated, against 1.2 changes based upon the diminution in CO_2 concentration. This discrepancy may be accounted to re-evaporation of condensation collected on the windows prior to 12:00 o'clock. The probability of reduction or addition in moisture content of the air due to dehumidification or re-evaporation under conditions when the window glass or other surfaces may be at or near the dewpoint would indicate a preference for accepting the equivalent air supply based upon the CO_2 determinations. However, the approach of agreement between the determinations when condensation was least likely to be a factor substantiates the deduction of a former Research Laboratory study[4]—that, when humidification or dehumification is not a factor, variations in moisture content or

[3]Heat and Moisture Losses From the Human Body and Their Relation to Air Conditioning Problems, by F. C. Houghten, W. W. Teague, W. E. Miller and W. P. Yant, A.S.H.V.E. Transactions, Vol. 35, 1929, p. 215.

[4]Indices of Air Change and Air Distribution, by F. C. Houghten and J. L. Blackshaw. A.S.H.V.E. Journal Section *(Heating, Piping and Air Conditioning)* June 1933, p. 324.

wet-bulb temperatures of the atmosphere in a room should be as good or better an index of air change and air distribution than CO_2 variations, because of the greater ease with which the wet-bulb temperature and moisture content determinations may be made.

The dilution formula referred to above was applied to the building up of the moisture content of the air within the room in the first study, based upon the number of occupants and other data. This is plotted as a broken line curve, "moisture inside-calculated," given in the lower section of the chart, Fig. 1. This curve was based upon an assumption of a continuous occupancy of 34 persons during the entire time, and a moisture dissipation from the occupants based upon an average dry-bulb temperature of 78 F from 8:30 a.m. to 9:35 a.m., and a dry-bulb temperature of 75 F thereafter. While the disagreement between this theoretical curve and that giving the results of actual observations is not great, they do indicate a considerably greater rate of building up of moisture content during the first hour than would be based upon the theoretical considerations and assumptions made in the calculated curves. The assumption of a continuous occupancy of 34 persons beginning with the time of 8:40 a.m. was probably too great for the first ten or fifteen minutes of the period. In spite of this fact, however, the curve giving the actual determinations in moisture content rose more rapidly than the theoretical curve. The first observation on which moisture content was based gave a value just equal to the theoretical at 8:56 a.m., with a continued high rate of building up thereafter. This may be accounted for by the fact that the children entering the room had previously been walking or exercising, thereby having in their clothing an excess amount of perspiration available for evaporation.

The first study was made on a cold day with the expectation that there would be no tendency for the rooms to overheat, or with the expectation that heat would have to be supplied in order to maintain the desired indoor temperatures. This expectation was not realized, however, as indicated by the rapid rise of the dry-bulb temperature after the occupants began to enter to a maximum of 79 F, in spite of the fact that only a very small amount of steam was supplied to the auxiliary radiator in the beginning of the period, which was all cut off as soon as the rise was noted. The temperature was high throughout the entire forenoon, never falling below 74 F. The high dry-bulb temperature taken together with the high moisture content gives an effective temperature range from a high of 71 F to a low of about 68 F. The room was therefore uncomfortably overheated throughout the test. The overheating was later accounted for by the observation that this room was located over the heating plant in the basement, and the added fact that solar radiation was effective through the glass throughout the forenoon. Because of the overheating experienced in this test, a temperature somewhat below normal or approximately 70 F dry-bulb, or 64 to 65 F effective temperature, was maintained during the second study.

This second study, made on the opposite side of the building, was not subject to solar radiation; neither was it subject to unusual heating from below. A small supply of steam was required in the auxiliary radiators throughout the forenoon in order to maintain the desired temperature. This heat requirement diminished to practically nothing during the last hour of the forenoon, indicating that the heat dissipated by the occupants was approximately equal to the heat loss from the room, with an outside temperature of 40.5 F and with no solar radiation entering through the windows.

During each of the three studies, three observers, the teacher of the particular room in which the study was made, and at various times other observers, including the principal of the school, made observations on the ventilation condition within the room, both as regards the general feeling of freshness and presence of odors, upon entering the room and after spending some time in the room.

In judging the condition of odors in the room studied, each observer recorded his judgment as (1) good—meaning that no pronounced odor was noticeable upon entering the room from the corridor of the building; (2) noticeable but not objectionable—meaning that a pronounced odor was noticeable, but that the observer did not judge it objectionable; (3) moderately objectionable—meaning that a pronounced odor was noticeable which was somewhat, though not positively objectionable; and (4) very objectionable.

The sense impression of odors is largely a relative reaction on the part of a person. Hence it should be noted that the above reactions were largely relative to the odor level in the corridor. However, since no noticeable odor was apparent upon entering the corridor from the outside, they may for practical purposes be considered a fair measure of the conditions of the room. It is a well recognized fact that a person may educate his sensitiveness to small variations of odors. No effort was made on the part of the observers to develop a special technique or a fine sense of differentiation. The observations recorded were therefore little different from what would be apparent to one entering such a room without making an effort to detect the slightest perception of an odor. This procedure, dictated by the short time allowed for the study, would therefore seem to give values of practical value in application.

As stated above, there was no noticeable odor in the corridor upon entering from the outside. Neither was there noticeable odor upon entering any classrooms in the building normally ventilated with approximately 30 cfm of air per person as determined by anemometer readings of velocity.

Each observer gave his judgment of the condition of odor by number as defined above. These numerical judgments by the different observers for a given condition were averaged and are recorded in the last column of Table 1, which also gives other data on each condition. The number of the study in which the observations were made is given in the first column. The extra, short-time observations made after the three half-day studies were completed are indicated as study "Ex."

The average odor intensity registered by the several observers are plotted against air change in cfm per person in Fig. 4. Different symbols are used for the different studies. A somewhat worse condition is indi-

cated for the same air change in the first study, when the temperature was high; however, there are too few points to draw a definite conclusion in this respect. While there is considerable spreading out of the points in Fig. 4, a rather definite relation between odor intensity and air change is indicated. Any condition

Table 1—Odor Impression for Different Rates of Air Change

STUDY NO.	TIME	DRY BULB TEMP.-°F	EFFECTIVE TEMP.-°F	EQUIVALENT AIR SUPPLY CFM	1-GOOD 2-NOTICEABLE BUT NOT OBJECTIONABLE 3-MODERATELY OBJECTIONABLE 4-VERY OBJECTIONABLE
1	9:20AM	79	71	6.8	3.7
1	10:00	75	68	4.1	4.0
1	10:45	74	68	2.8	4.0
1	11:30	73	68	3.1	4.0
2	9:05AM	68	64	8.0	2.5
2	9:17	70	65	6.8	3.0
2	9:35	68	64	5.3	3.2
2	10:40	70	65	4.0	3.7
2	11:10	70	64	5.6	4.0
2	12:NOON	71	66	3.3	4.0
3	8:44AM	69	64	10.0	2.0
3	8:50	70	65	7.5	3.0
3	9:40	70	65	4.0	3.7
3	10:42	70	66	3.8	4.0
3	11:07	70	65	6.4	3.5
3	11:29	70	65	7.4	3.2
3	11:50	70	65	9.0	2.5
EX		70	65	12.2	1.7
EX		71	66	16.0	1.2
EX		71	65	13.3	1.2
EX		71	66	14.2	1.5

studied with less than 5 cfm per person is shown to be positively objectionable.

If an odor intensity classed as "noticeable but not objectionable" is taken as the lower safe limit of air change, then an air change of from 10 to 11 cfm per person is indicated as necessary. From the observations made in this study, this air change should insure freedom from odors which are noticeable to one not trained in observing them and not particularly looking for their presence. For economy in ventilation, a level midway between (2) and (3), or midway between "noticeable but not objectionable" and "moderately objectionable" may be acceptable. This would permit a reduction in air change to approximately 8 or 9 cfm per person.

It should be emphasized that these deductions apply only to children of junior high school age, or those having an average body surface area of 17.0 sq ft. Since all metabolic processes are assumed to be proportional to body surface area, it is safe to assume that odors may also obey this law, and that when personal cleanliness is not a factor, air change should vary with reference to the body surface area of the occupants.

Provided the temperature of the room was not too high (above 66 F effective temperature), the observers could not notice the odor in the room after being in it for several minutes. Neither was any other discomfort noticeable. In the first study, however, when the effective temperature rose to from 68 to 71 F, great discomfort was noticeable. Odors were apparently not noticed as such, but the air seemed stuffy and the humidity seemed to be noticeable. The teacher in this room, who had no particular knowledge of air conditions in general and who was not informed concerning changes being made in the room, classified the air as "heavy and oppressive." While the conditions were at their worst as far as temperature was concerned, at about 9:30 a.m., the teacher felt it necessary to leave the room for a while to "get a breath of lighter air." If the temperature had not fallen slightly, soon after this time, it is doubtful if she could have been prevailed upon to continue her class. The children were noticeably restless and uncomfortable. The teacher stressed the fact that several children asked permission to go to the toilet room, when under ordinary circumstances there would rarely have been one such request. Whether this resulted from restlessness and a desire to get away from the uncomfortable condition, or from a physiological derangement, is not known. While the observers had no particular facts or comparisons on which to base their opinions, they were of the opinion that conditions in the room were much less bearable than would be the case with an equally high effective temperature with a greater supply of outside air. It is well to observe that the room was not wanting in air movement, for the unit ventilator was recirculating the usual volume of room air.

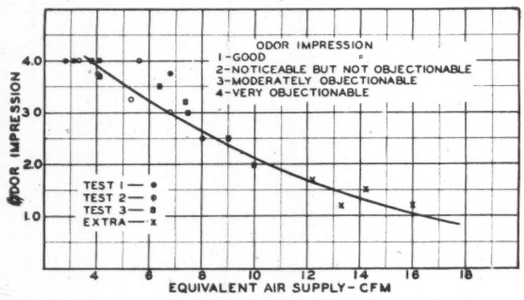

Fig. 4—Relation between odor intensity and air supply

Provided the room temperature was not high, there was no apparent sensation of stuffiness or lack of freshness of the air in the rooms to one in a room for some time. Particularly in the second study, when an effective temperature of from 64 to 65 F was maintained, the condition felt invigorating and the children seemed alert. The teacher pronounced the condition as very good, except for the sensation of odor upon entering the room.

Summary

1. In a classroom of conventional size, air leakage and the initial room air volume was found to give an air change of from 1 to 1½ per hour, or an air supply per person in the rooms studied of from 2 to 5 cfm.

2. Odors are little noticed by the occupants of a room, but are noticeable to one entering from a space with a lower odor intensity.

3. Overheating gives a more pronounced sensation of discomfort than odors.

4. Odors are noticeable to one entering a room and looking for them when the air change drops below 11 cfm per person. With an air change of approximately 9 cfm per person, they become noticeable without looking for them, though not particularly disagreeable. With an air change of approximately 7 cfm per person, they become noticeably disagreeable.

Air Diffusion in Ventilation Systems

By **R. C. Jordan*** ***(MEMBER)***

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THE word diffusion, as applied to ventilation work, is an ambiguous one. Theoretically, it means the interchange of molecules by spontaneous process when two miscible fluids or gasses are brought in contact with each other. Practically, it means the spreading or dissemination of the incoming air throughout the room. Practically, air diffusion is accomplished by the following factors: pressure, viscosity, turbulence, interchange of molecules, temperature, and velocity. Each of these factors will be discussed in turn.

The first of these, pressure, may be reasonably disregarded in ventilation work with the exception of its influence on the density and the velocity of the air itself. This liberty may be taken because the range of pressures used in ventilation work varies only slightly from atmospheric pressure.

The second factor, viscosity, is the term used to denote the resistance offered by the fluid or gas to the relative motion of its particles. The equation[1] used to denote the viscosity of a gas is:

$$u = (358 + 0.932T) \times 10\text{-}^{9}.$$

Where: u = viscosity in foot-pound seconds.
T = Absolute temperature degrees Fahrenheit.

The percentage of change in viscosity of air is about one and one half per cent for every 10 deg temperature change. Consequently, in comparing the results obtained in air diffusion tests in which the temperature differences are only slight, it is permissible to disregard the effect of viscosity.

Investigations[2] by Osborne Reynolds in 1883 showed, among other things, that when a fluid is projected into another fluid at rest, the conditions tend to give rise to turbulent flow. It follows that in ventilation work the flow of air into rooms is necessarily a turbulent process, and while in ventilation studies it is impossible at any time to eliminate entirely this factor, the amount of turbulence can be varied and its effects studied relatively.

The fourth factor under consideration, interchange of molecules is the spontaneous process which results when two miscible liquids or gasses are brought in contact with each other. The general equation[3] valid for diffusion through both liquid and gaseous films is:

$$dN/d\theta = D\ A\ dc/dx$$

Where: N = Number of mols transferred
θ = Time in seconds
D = Diffusion constant
A = Area of interfacial contact
c = Concentration in mols per cubic centimeter
x = Distance in centimeters measured in direction of diffusion.

This equation is only valid for still air as it is impossible to evaluate correctly all the factors in cases where turbulent flow is involved. In ventilation work, however, this factor will remain constant except for changes due directly to changes in air temperature, velocity, and turbulence. Therefore, this can be considered as a dependent factor, controlled by the independent variables: temperature, velocity and turbulence.

Temperature has its effect upon diffusion of air by changing the factors of viscosity and interchange of molecules as previously discussed, and also by changing the density of the air. A difference in density between the incoming air and the room air results in imparting a vertical motion to the incoming air, the direction and rate of motion depending upon the relative densities.

The last factor, velocity, affects the diffusion of the air by increasing or decreasing the rate of supply of new air into the room, by changing the rate of interchange of molecules by its effect upon the area of interfacial contact as previously discussed, by increasing the tendency towards turbulent flow with increased velocities, and by causing an induced circulation of the surrounding air at high velocities.

From the preceding discussion it may be seen that: first, it is impossible to make a mathematical analysis of the problem because of the complications involved due to turbulent flow; second, the factors, pressure, viscosity, and interchange of molecules may be disregarded in studying the problem. This may be done because the first two vary only negligibly, and the third is dependent upon the factors, temperature, velocity, and turbulence. Therefore, it is only necessary to control the three dependent variables, temperature, velocity, and turbulence in order to study the diffusion of air in ventilation systems. The first two of these factors are easily controlled and measured, and the third can be varied and studied relatively.

Apparatus

The apparatus used to conduct these diffusion tests consisted of a blower which supplied air to a mixing chamber in which were located smoke pots and apparatus for their ignition. A 15 ft duct carried air from this chamber through a velocity measuring bell orifice and hence into the room. Various types of outlets were placed on the end of this duct and the flow of air viewed from a position 40 ft away. A permanent record of the contour lines formed by the outlet air was obtained by recording the intersection of the smoke boundary lines and the lines on a charted background consisting of 1 ft squares. This background was 8 ft high, 16 ft long, and was placed 50 ft away from the point of observation parallel to the direction of travel of the mixture of smoke and air. The velocity of the air was adjusted by means of a damper placed at the outlet of the mixing chamber, and the temperature of the air was regulated by means of a duct and damper running from the exterior of the building to the inlet of the blower. The apparatus and test results were

*In charge of Air Cond. Dept., Central Supply Co.
[1]Gibson, *Hydraulics and Its Applications.*
[2]Phil. Trans. Roy. Soc. 1883.
[3]Arnold, J. Howard, Studies in Diffusion, in Industrial and Engineering Chemistry, October, 1930.

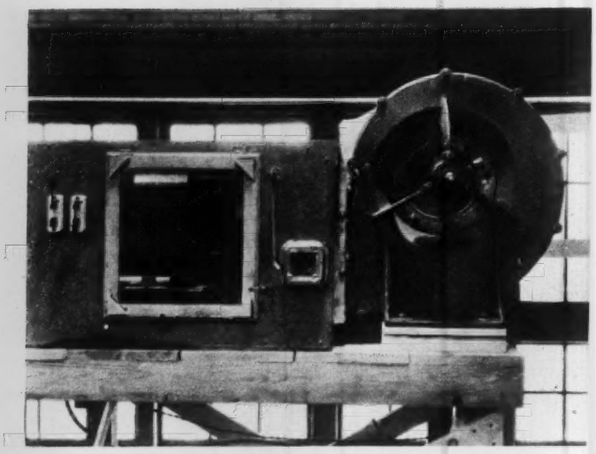


Fig. 1—View of mixing chamber, time ignition apparatus, and blower

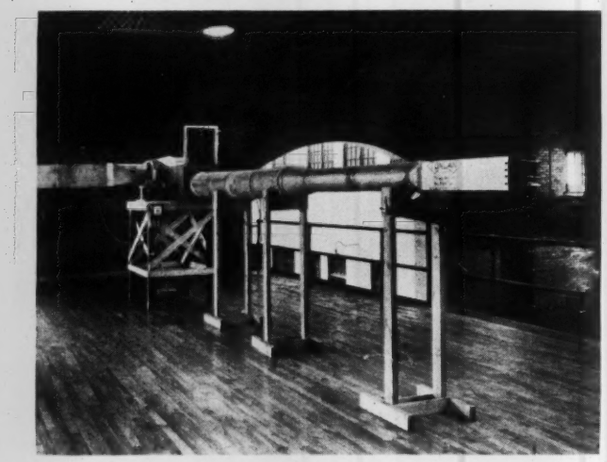


Fig. 2—View of complete apparatus, showing vanes attached to end of outlet

calibrated for velocity, temperature rise due to impact of air on the thermometer located in the mixing chamber, temperature rise due to ignition of the smoke pots, and vertical parallax of chart readings. This last calibration was necessitated because of the constant level at which the visual observations of the chart were made. Horizontal parallax was eliminated by the observer's moving horizontally as the readings were recorded. Fig. 1 shows a view of the mixing chamber, time ignition apparatus and the blower. Fig. 2 shows a view of the complete apparatus with vanes attached to the end of the outlet. Fig. 3 shows the various outlets which were placed on the end of the air duct during these tests.

Procedure

The various steps in making an actual test were as follows: The required outlet was first fastened to the duct in the position desired. In the case of the abrupt enlargement, the sliding sleeve was adjusted so that the distance from the point of abrupt enlargement to the point of outlet was as desired. In the case of the outlet equipped with vanes, the length and angle of the vanes was set as desired. In the other cases no adjustment was necessary. A smoke pot was next positioned for ignition, the blower started, and the outlet temperature and velocity adjusted. The ignition time clock was then set, and the observer stationed in position to record the results of the test. Tests were made using these openings: bell orifice, flat plate orifice, vanes on exterior of square duct, and adjustable abrupt enlargement.

Results

Bell Orifice

Figs. 4 and 5 show the results obtained from tests on a bell orifice (this type of opening approximating stream line flow) for the velocities 500, 1000, 1500 and 3000 fpm, and for temperature differences between duct outlet air and room air of 3 and 10 deg. Table 1 shows the spread in feet between the upper and lower streamlines at the section 16 ft from the outlet for each test with the bell orifice.

Table 1—Air Spread for Bell Orifice at 16 Ft from Outlet

Velocity	3 Deg Temp. Difference	10 Deg Temp. Difference	Difference
500	2.11	3.90	1.79
1000	2.96	3.20	0.24
1500	3.75	3.90	0.15
3000	3.75	3.90	0.15

From an inspection of the above table and curves on the following page, it appears that there are three factors affecting the flow of air through the bell orifice, namely: temperature, velocity, and induced circulation. Temperature difference creates a tendency for the air to rise or fall, this tendency naturally being greater for the 10 deg difference in temperature than the 3 deg difference. Velocity has a tendency to offset this effect of temperature, and to maintain the flow along a center line extended from the duct outlet. Velocity also appears to cause a certain degree of induced circulation and in this manner increases the diffusion of the air. Induced circulation is differentiated from turbulence in that it does not materially break down the flow of air but rather causes a counter-circulation, through friction, of the surrounding layers of air.

Table 1 shows that the spread of air increased with increased velocity at the 3 deg temperature difference. At 1500 and 3000 fpm the spread was the same. With a 10 deg temperature difference the spread first decreased and then increased with increased velocity. The spread at 500, 1500 and 3000 fpm was the same. This indicated from the tests that at 500 fpm the large temperature difference caused a considerable spread,

Fig. 3d—Abrupt enlargement

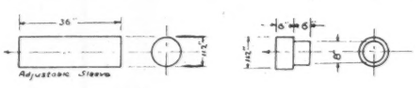


Fig. 3c—Square duct

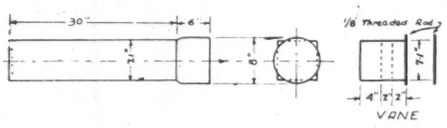


Fig. 3b—Flat plate orifice

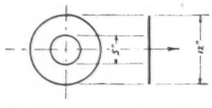
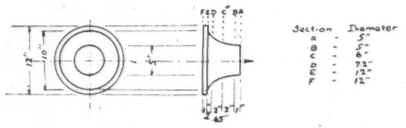


Fig. 3a—Bell orifice



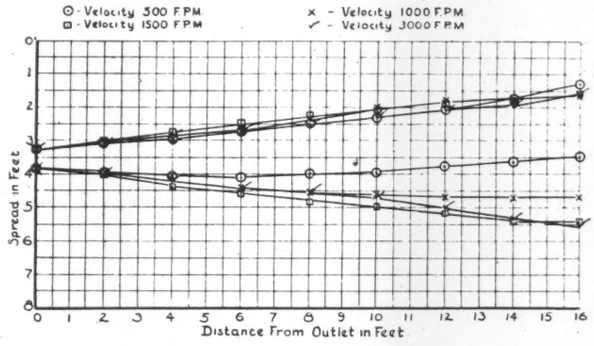


Fig. 4—Bell orifice. Outlet air 3 deg above room temperature

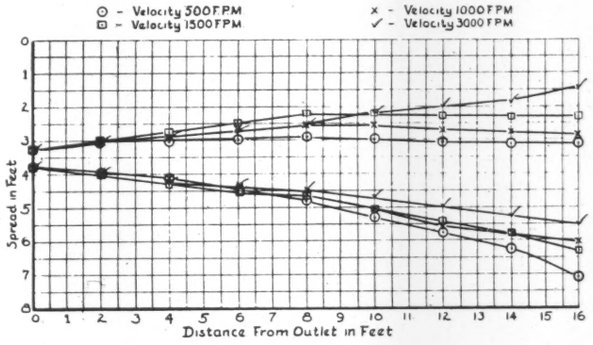


Fig. 5—Bell orifice. Outlet air 10 deg below room temperature

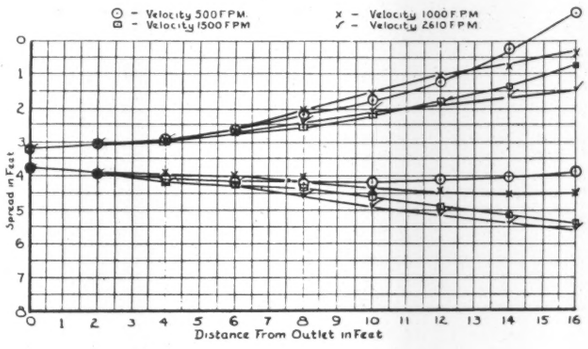


Fig. 6—Flat plate orifice. Outlet air 3 deg above room temperature

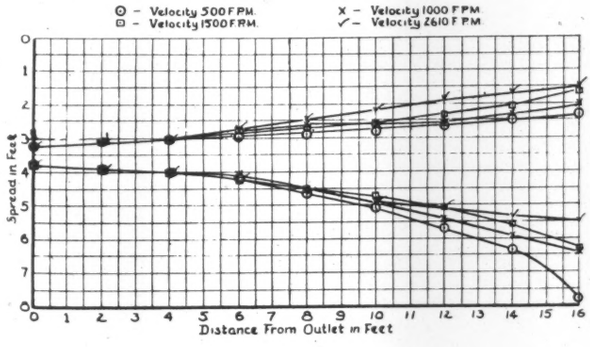


Fig. 7—Flat plate orifice. Outlet air 10 deg below room temperature

while at 1000 fpm the increased velocity offset this temperature effect and reduced the spread, and at higher velocities than 1000 fpm the spread was increased by the increase in induced circulation. The last column shows the difference between the air spreads at 3 deg and 10 deg temperature difference for different velocities. This difference decreased with increased velocity, showing that the effect of temperature was counteracted by velocity.

Flat Plate Orifice

Figs. 6 and 7 show the results obtained from tests on a flat plate orifice for velocities of 500, 1000, 1500 and 2610 fpm, and for temperature differences between duct air and room air of 3 and 10 F. Table 2 shows the spread in feet between the upper and lower contour lines at the section 16 ft from the duct outlet.

Table 2—Air Spread for Flat Plate Orifice at 16 Ft from Outlet

Velocity	3 Deg Temp. Difference	10 Deg Temp. Difference	Difference
500	4.68	5.47	0.79
1000	4.13	4.28	0.15
1500	4.60	4.52	—0.08
2610	4.05	3.97	—0.08

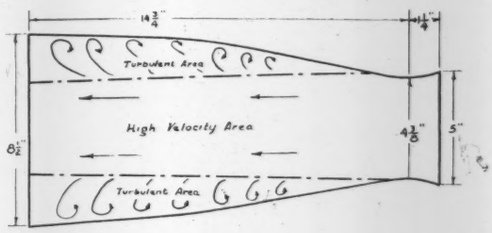


Fig. 8—Air flow, flat plate orifice, velocity 2610 fpm

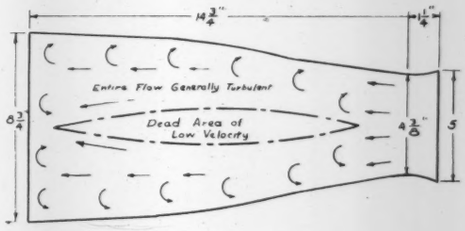


Fig. 9—Air flow, flat plate orifice, velocity 500 fpm

Figs. 8 and 9 show reproductions of flow patterns of the air flow through this orifice at outlet velocities of 500 and 2610 fpm. These flow patterns were formed by exposing a glass plate coated with a solution of lampblack and kerosene to the flow of air at the mouth of the orifice. The passage of air over the solution evaporated the kerosene and left the contour lines of the air flow imprinted in the dried lampblack. These were taken because it was noticed that there was considerably more turbulence at low than at high velocities. This indicates that in the flat plate orifice besides the factors of temperature, velocity, and induced circulation affecting the flow of air, there is also an increased amount of turbulence over that found in the flow through the bell orifice. Table 2 shows that at both the 3 and 10 deg temperature differences, the spread is greater at 500 fpm than in the case of the bell orifice. This is apparently due to the increase in turbulence. At 1000 fpm the spread is reduced, apparently

due to the counteracting effect of the increased velocity. At 1500 fpm the spread in both cases is increased, apparently due to the introduction of induced circulation. At 2610 fpm the spread is reduced to its lowest value. At this velocity the turbulence is at a minimum, and apparently more than offsets any increased spreading effect due to an increase in induced circulation. The difference column shows that as the velocity is increased, the difference between the air spreads for the 3 and 10 deg temperature differences is counteracted and reduced. The negative values are small and may be disregarded, as they are within the range of experimental error.

A comparison between the values recorded in Tables 1 and 2 indicates the effect of turbulence upon the flow of air through an outlet. The bell orifice air flow approaches stream-line flow, while the flat plate orifice gives rise to turbulence especially at the lower velocities. At the higher velocities where turbulence is minimized with the flat plate orifice, the spread values for the two types of openings approach each other. At the lower velocities, the spread values for the flat plate orifice are considerably larger than for the bell orifice. This is due to turbulence. As a result the air does not flow as far from the opening before the velocity head is consumed. This causes good diffusion in the vicinity of the outlet, but bad distribution throughout the remainder of the room.

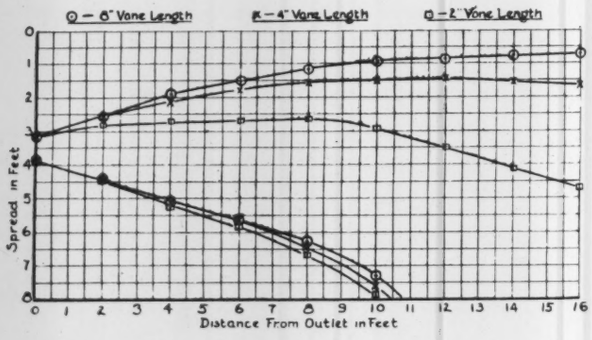


Fig. 10—Duct with vanes, Air flow velocity, 500 fpm. Vane angle, 15 deg. Air 10 deg below room temperature

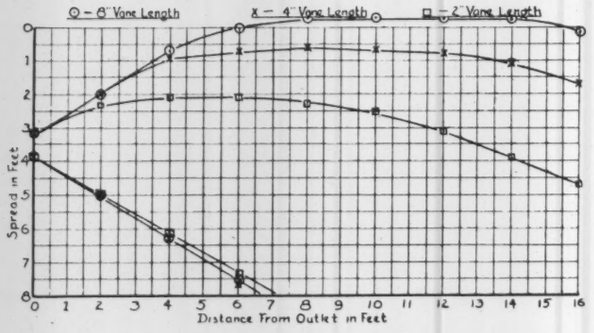


Fig. 11—Duct with vanes. Air flow velocity, 500 fpm. Vane angle, 25 deg. Air 10 deg below room temperature

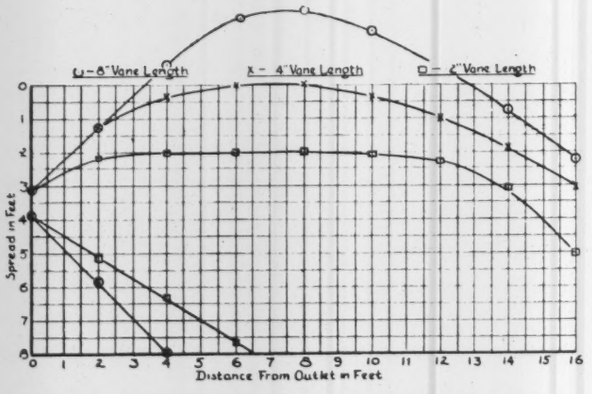


Fig. 12—Duct with vanes. Air flow velocity, 500 fpm. Vane angle, 35 deg. Air 10 deg below room temperature

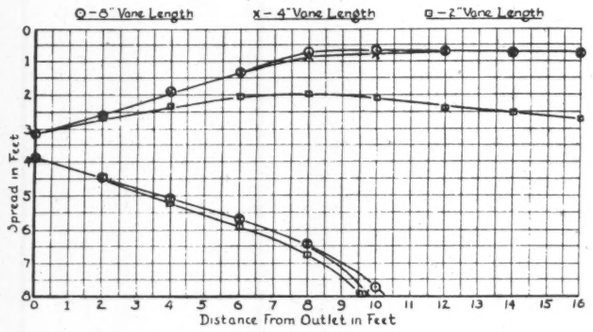


Fig. 13—Duct with vanes. Air flow velocity, 1500 fpm. Vane angle, 15 deg. Air 10 deg below room temperature

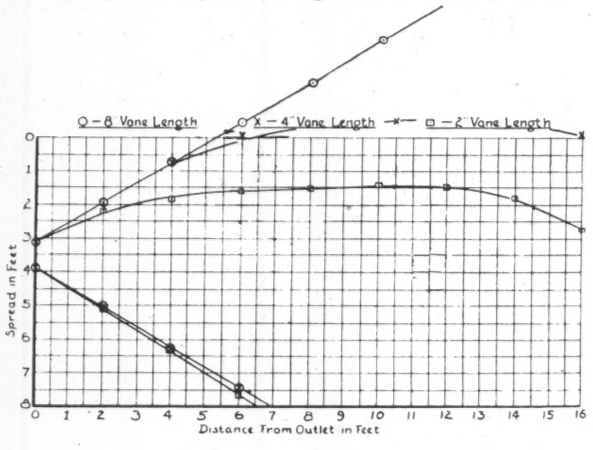


Fig. 14—Duct with vanes. Air flow velocity, 1500 fpm. Vane angle, 25 deg. Air 10 deg below room temperature

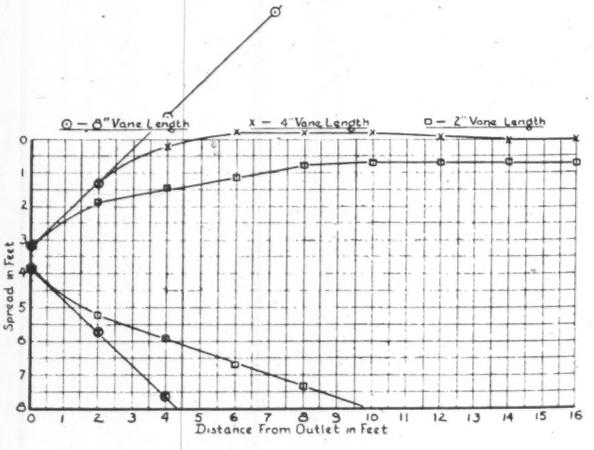


Fig. 15—Duct with vanes. Air flow velocity, 1500 fpm. Air 10 deg below room temperature

Vaned Duct

Figs. 10 through 15 show the effect of velocity, vane angle, and vane length upon the flow of air through a square duct, when the outlet air is 10 F below room temperature. The vane angle is the angle between any two consecutive vanes of the four vanes, and the vane length the dimension of the vane in the direction of the air flow. The velocity in these tests was varied between 500 and 1500 fpm, the vane angle between 15 and 35 deg, and the vane length between 2 and 8 in.

It should be noted that in all cases the lower stream-line intersects with the floor line before the air has travelled 16 ft from the duct. Consequently, the distance between the floor line and the upper stream-line at the section 16 ft from the duct is a measure of the air flow's ability to counteract the effect of the difference in density between the room air and the duct air. This measure has been termed Vane Effectiveness in Table 3.

Table 3—Vane Effectiveness

Velocity, FPM	Vane Angle, Deg	Effectiveness 8 in. Length	4 in. Length	2 in. Length
500	15	7.31	6.29	3.33
500	25	7.85	6.24	3.33
500	35	5.67	4.89	2.94
1500	15	7.23	7.23	5.28
1500	25	12 plus	8.01	5.28
1500	35	12 plus	8.01	7.23

It should be noted that the effectiveness decreased at 500 fpm, when the vane angle was increased. At the velocity of 1500 fpm the effectiveness increased as the vane angle increased. This indicates that increasing the vane angle will not necessarily increase the spread of air. At 500 fpm there was not enough energy imparted to the air to sustain flow against the difference in air density when the vane angle was increased. At 1500 fpm there was enough energy to take care of this increase in vane angle.

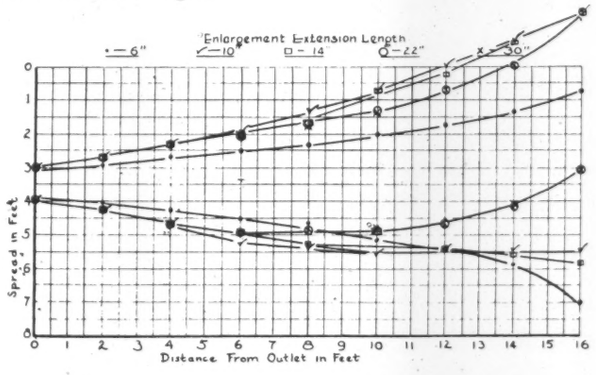


Fig. 16—Abrupt enlargement. Air flow velocity, 500 fpm. Air 3 deg above room temperature

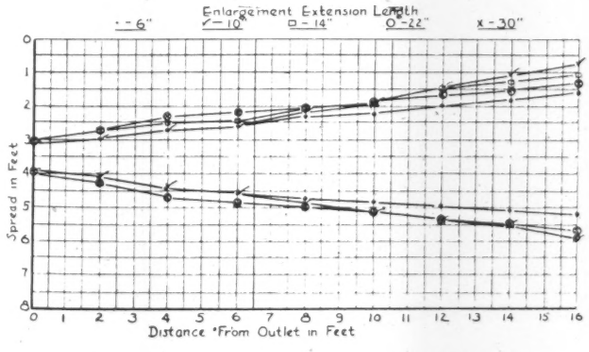


Fig. 17—Abrupt enlargement. Air flow velocity, 1500 fpm. Air 3 deg above room temperature

A comparison of the vane effectiveness at the two velocities for any one vane length showed them to be nearer the same when the vane angle was at the minimum of 15 deg. The greatest difference in the vane effectiveness came when the vane angle was the maximum of 35 deg. This indicates that, if the vane angle is small, a high velocity is not as important to good diffusion as when the vane angle is large. The vane effectiveness at all angles and all velocities decreased as the length of the vane decreased. Thus, it appears that the length of the vane is just as important at low velocities as at high velocities. The minimum increase in vane effectiveness accompanying an increase in vane length from 2 to 8 in. was 36 per cent. It appears that at large vane angles and short vane length, turbulence results, thereby causing poor distribution of the air. This was substantiated by the fact that the static pressure in the duct behind the outlet increased as the vane length decreased when the vane angle was at 35 deg. It is interesting to note that with a velocity of 1500 fpm the vane effectiveness is the same when the vane length is 8 in. and the vane angle 15 deg, as when the vane length is 2 in. and the vane angle 35 deg. At a velocity of 500 fpm the vane effectiveness at the vane length of 8 in. and a vane angle of 15 deg is 2.48 times greater than when the vane length is 2 in. and the vane angle 35 deg.

Abrupt Enlargement

Figs. 16 and 17 show the effect of velocity and length of distance between outlet and point of abrupt enlargement upon the flow of air through a duct designed with an abrupt enlargement. The outlet temperature of the air was 3 F above room temperature on all runs. Table 4 shows the actual spread between the upper and lower contour lines at the section 16 ft from the outlet. The velocities indicated are based upon the area of the duct before enlargement.

Table 4—Air Spread for Abrupt Enlargement at 16 Ft from Outlet

Distance in Inches From Outlet to Point of Abrupt Enlargement	Actual Spread in Feet 500 FPM	1500 FPM
30	4.68	4.13
22	4.68	4.13
14	7.40	4.68
10	7.02	5.07
6	6.16	3.51

The principal object of these runs was to determine what distance was necessary between the duct outlet and the point of abrupt enlargement to allow the air to expand fully to the larger area and issue from the duct without turbulence. An inspection of the curves and the table will show that at 30 in. and at 22 in. extension distance, the flow was the same at both velocities. This indicated that at this distance the air had fully expanded and was issuing from the duct with comparatively little turbulence. As the length of the extension was reduced, the spread became greater, indicating that due to only partial expansion of the air before the point of outlet into the room, turbulence was being introduced. When the extension was reduced to its minimum length of 6 in., the spread also was reduced. This indicated that the length of extension was so short that it had little effect upon the flow of air from the duct, the flow being again comparatively free from turbulence. This conclusion was substantiated by the fact that at the point of outlet the air was not fully expanded to the outlet area. The greatest turbulence on

the last two runs was at the velocity of 500 fpm. This was consistent with the fact that the spread was considerably greater at 500 fpm than at 1500 fpm on all runs.

Conclusions

The following conclusions may be drawn from these studies:

1. There are three main factors which affect the flow of air through a ventilation outlet; namely, temperature, velocity, and turbulence. Two other important factors, interchange of molecules and induced circulation, are dependent upon these main factors.

2. If the outlet velocity of the air is low (500 fpm), a temperature difference of 3 deg or more becomes a dominant factor, causing the air either to rise or fall within 16 ft of the outlet.

3. If the outlet velocity of the air is high (2000 to 3000 fpm), the effect of a 10 deg difference in temperature can be neutralized with little tendency for the air to rise or fall within 16 ft of the outlet.

4. A high outlet velocity (2000 to 3000 fpm) results in an induced circulation of the surrounding air which aids in the distribution of the air.

5. The introduction of turbulence at the point of outlet tends to cause good diffusion at the point of outlet, but bad distribution throughout the remainder of the room, unless the room is small.

6. On a vaned outlet, increasing the vane angle will not necessarily increase the spreading of the air, if the velocity head is insufficient.

7. On a vaned outlet, a high velocity is not as important to good distribution of the air when the vane angle is small (15 deg) as when it is large (35 deg).

8. A short vane length (2 in.) introduces turbulence when the vane angle is large (35 deg) and results in an increase in static pressure back of the outlet, and a decrease in distribution of the air throughout the room, unless the room is small.

9. The distribution of the air through a vaned duct is decreased at all vane angles and all velocities when the length of the vane is decreased.

10. If the distance from a point of abrupt enlargement to the point of duct outlet is too short, (6 in. when ratio of areas is 2:1), the abrupt enlargement will have little effect upon the flow of air.

11. There is a critical distance between the point of abrupt enlargement and the duct outlet which will introduce excessive turbulence into the air stream.

Air Conditioning Manufacturers' Association Moves to Washington

Leading manufacturers of air conditioning equipment who compose the membership of the *Air Conditioning Manufacturers' Association* (formerly Unit Air Conditioner Manufacturers' Association) in a meeting last week voted to move their association headquarters to Washington, D. C. Offices have been opened in the Southern Building and W. B. Henderson will serve as Executive Secretary.

With wide public interest in and acceptance of air conditioning as a practical necessity not only for industrial processing but also for human comfort, this rapidly growing industry assumes a particularly important and strategic place in the outlook and plans for business and economic recovery.

Public recognition of air conditioning as a regular and commonplace part of daily life will rest largely on the shoulders of the responsible, reliable and progressive manufacturers who have the public interest foremost in their operations. The members of the *Air Conditioning Manufacturers' Association* have made distinct cooperative progress in standardization of equipment rating, installation, and application of air conditioning, and are establishing broad and sound trade practices in an effort to avoid the abuse of public confidence from which other rapidly growing industries have suffered in the past.

Distinctly forward steps in this cooperative work are planned for discussion and action at a meeting of *ACMA* called for Hot Springs, Va., on May 23. Present members of *ACMA* are: Carrier Engrg. Corp., Newark, N. J.; De La Vergne Engine Co., Philadelphia, Pa.; General Electric Co., New York, N. Y.; Kelvinator Corp., Detroit, Mich.; J. H. McCormick & Co., Williamsport, Pa.; J. J. Nesbitt, Inc., Philadelphia, Pa.; Parks-Cramer Co., Fitchburg, Mass.; B. F. Sturtevant Co., Boston, Mass.; Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.; York Ice Machinery Corp., York, Pa.

Work–Relief Bill

The great $4,880,000,000 Work-Relief Bill gives the President all the money and most of the powers he first asked and he has indicated that he alone will take the responsibility for its allocation.

To the engineers, this measure brings deep responsibilities for, without engineering technique, such a program could neither be planned nor executed. It brings complex problems of professional status and of adjustment to new lines of activity. But most of all, the program brings hope to thousands of engineers now losing their skill in idleness or in makeshift jobs.

The engineering nature of the program becomes evident from the type of projects earmarked in the bill. The $4,880,000,000 represents an appropriation of 4 billion dollars plus the release of approximately 880 million dollars from past appropriations. The latter sum is mainly for continuance of relief through June 30 and for repayment of PWA funds temporarily used for relief while passage of the bill hung fire.

American Engineering Council, representatives of its member societies, and allied groups are actively negotiating in Washington with regard to the engineers' part in the vast program.

F. Paul Anderson Medal to be Awarded

The Committee on the F. Paul Anderson Medal Award invites all members of the Society to submit the names of candidates for the second award of the F. Paul Anderson Medal to be made at the 42nd Annual Meeting of the Society in January, 1936.

Chairman G. L. Larson has outlined briefly the conditions under which the award is to be made as follows:

(1) Any member of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS in good standing during 1935 is eligible for nomination.

(2) Each nomination sent to the Committee on Award must be accompanied by a statement of the candidates' accomplishments, specifically mentioning the work done or services performed and indicating in what way such work or services have been outstanding in the field of heating, ventilating or air conditioning, during 1935 or any year prior thereto.

(3) All nominations must be in the hands of the Committee on July 1, 1935 and are to be addressed to the Committee on F. Paul Anderson Medal Award, c/o Secretary, AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS, 51 Madison Ave., New York City.

At the Annual Meeting in Buffalo the Council appointed the Committee and Pres. John Howatt announced the personnel as follows: G. L. Larson, *Chairman,* H. P. Gant, L. A. Harding, S. R. Lewis and W. E. Stark.

Under the regulations governing the F. Paul Anderson Award, the Committee will report to the Council at its last meeting of the calendar year and the presentation of the medal will be scheduled for the Annual Meeting in January 1936.

The F. Paul Anderson Award was created and announced at the 36th Annual Meeting by Pres. Thornton Lewis and the first presentation of the medal was made to W. H. Carrier at the 38th Annual Meeting in Cleveland January 1932.

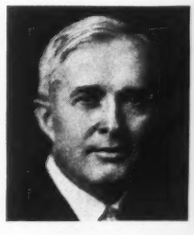
The medal is named for the late F. Paul Anderson, Past President of the Society, a former Director of the Research Laboratory and for over 40 years Dean of the College of Engineering at the University of Kentucky. The F. Paul Anderson Medal was designed by John Swanson and carries a likeness of Dean Anderson on one side and on the reverse side figures typifying heating and ventilating.

The Committee on Award will welcome the cooperation of members of the Society and urge them to send their recommendations promptly.

G. L. Larson
Chairman

H. P. Gant

L. A. Harding



S. R. Lewis

W. E. Stark

Skyline of Toronto

Toronto Is the Meeting Place

MEMBERS of the Society will assemble in Toronto as guests of the Ontario Chapter, June 17-19, for the Semi-Annual Meeting of the A.S.H.V.E. It is significant that the meaning of "Toronto" is "Place of Meeting" and was so named by the Indians many years before the adventurous pioneers came to America. Located on the shores of Lake Ontario, Toronto is a city of over 750,000 population and is the capital and social, political, financial, and industrial center of Ontario and one of the world's foremost cultural and educational centers.

Members visiting Toronto will find magnificent government buildings, imposing university and public building groups, beautiful parks, boulevards, modern shops, theatres, and attractive residential sections. Throughout the city are many parks and pleasure resorts and among the city's famous attractions are Queen's Park, High Park, and Sunnyside, where there are countless amusement features. Places that sightseers will wish to visit are the Parliament Buildings, City Hall with its famous clock tower, the University of Toronto, the Zoological Gardens, the Royal Ontario Museum, the Coliseum, the Public Library, the Art Gallery, and Exhibition Park.

Toronto is readily accessible from all parts of Canada and the United States and through train service is supplied by the Canadian Pacific and Canadian National Railways.

Low rates of fare are available to members of the Society and the round-trip can be made for fare and one-third from any point.

Royal York Hotel

Headquarters of the meeting will be at the Royal York Hotel, the largest hotel in the British Empire, and the most recent of the Canadian Pacific hotel chain, which stretches from the Atlantic to the Pacific. The Royal York is located in the heart of the downtown district, commands a magnificent view of Lake Ontario, and is connected by tunnel with the Union Station.

The technical sessions will be held each morning in the Ball Room located on the second floor.

Members and guests will find that a splendid and varied entertainment program has been arranged for the afternoon and evening hours. There will be sightseeing and inspection trips for those who do not play golf; the ladies will be entertained at luncheon and tea and will enjoy a card party and shopping tour. Everyone is invited to participate in the Get-Together luncheon on Monday at noon, the Informal Dinner and Dance at the Old Mill Monday evening, and the Semi-Annual Banquet and Dance on Tuesday evening at the Royal York.

The Semi-Annual Meeting 1935 affords an opportunity to enjoy a combined business and vacation trip in Canada, with the possibility of a trip through the Thousand Islands or a cruise on the Great Lakes.

Members of Ontario Chapter look forward to the pleasure of being hosts to their fellow-members of the Society, June 17-19, and tentative arrangements made to entertain the members and ladies assure a really enjoyable series of events for the three-day stay in Toronto.

The Committee on Arrangements is: *Chairman*—E. H. Gurney; *Vice-Chairman*—L. L. Anthes; *Finance*—M. F. Thomas; *Publicity*—E. R. Gauley; *Ladies*—H. B. Jenney and Mrs. E. H. Gurney; *Banquet*—Thomas McDonald; *Entertainment*—W. P. Boddington; *Transportation*—M. W. Shears; *Reception*—H. H. Angus; *Registration*—J. S. Paterson; and *Secretary*—H. R. Roth.

The details of the tentative program are given so that members may visualize the good things for the Semi-Annual Meeting 1935.

Railroad Rates to Toronto

From	One-Way Fare	Reduced Round Trip Fare
Montreal	$ 11.50	$ 15.34
Quebec	17.15	22.87
Ottawa	8.50	11.34
Winnipeg	38.75	51.67
Vancouver	78.21	103.35*
Buffalo	3.67	4.90
Boston	21.49	28.66
New York	17.96	23.75
Philadelphia	18.65	24.87
Baltimore	17.94	23.72
Washington	19.38	25.84
Cincinnati	17.28	23.04
St. Louis	25.74	34.32
Kansas City	31.49	48.65*
Los Angeles	84.24	116.15*
Seattle	78.21	103.35*
San Francisco	84.24	108.15*
Denver	48.77	63.60*
Chicago	17.71	23.62
Detroit	7.90	10.54
Indianapolis	17.48	23.31
Cleveland	10.31	13.75
Pittsburgh	12.87	17.16

*Summer Tourist Fare.

TENTATIVE PROGRAM, SEMI-ANNUAL MEETING 1935

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Royal York Hotel, Toronto, Ont., Can.

June 17-19, 1935

Sunday, June 16, 1935

6:30 p.m. Dinner and Meeting of the Council.

Monday, June 17, 1935

9:00 a.m. Registration.

10:00 a.m. Technical Session:
Characteristics of Registers and Grilles, by J. H. Van Alsburg.
Classroom Odors with Reduced Outside Air Supply, by F. C. Houghten, H. H. Trimble, Carl Gutberlet, and M. F. Lichtenfels.

12:15 p.m. Get-Together Luncheon for Members and Ladies.

1:00 p.m. Cars leave hotel for Weston Golf Club.

1:30 p.m. 18 Hole Handicap Golf Tournament for Research Cup.

3:30 p.m. Sight-seeing Trip for Ladies and Members through City of Toronto ending at the Old Mill.

7:30 p.m. Informal Dinner followed by Dancing for Members and Ladies at the Old Mill.

Tuesday, June 18, 1935

9:30 a.m. Technical Session:
Cooling and Air Conditioning an Ale Brewery, by C. P. Creighton and F. J. Friedman.
A Field Survey and Test of Intermittent Oil Burner Operation, by D. W. Nelson.
Design and Operation of the Heating Systems at Mt. Holyoke College, by C. W. Colby.

10:30 a.m. Inspection of Art Gallery and Ontario Museum by the Ladies.

1:30 p.m. Informal Golf Matches for Members.

2:00 p.m. Boat leaves wharf for Toronto Yacht Club where luncheon will be served for the ladies to be followed by bridge.

2:30 p.m. Visit and Inspection of Research Foundation.

7:30 p.m. Dinner Dance for Members and Ladies at the Royal York Hotel.

Wednesday, June 19, 1935

9:30 a.m. Technical Session:
Study of Air Filters, by F. B. Rowley.
All Electric Heating and Cooling System, by P. Sporn.
Discussion of Certified Air Conditioning, by S. R. Lewis

11:00 a.m. Shopping Tour of Toronto Stores for Ladies.

12:30 p.m. Luncheon Meeting of Nominating Committee.

PRESIDENT'S MESSAGE TO MEMBERS

SUMMER MEETING

CANADA! There is a lure and romance to the name that intrigues those south of its boundary line.

Our Canadian Chapter is to be our host for the 1935 Summer Meeting in Toronto, June 17-19. Those who were fortunate enough to attend the last summer meeting when the Ontario Chapter was in charge of affairs will never forget the delightful experience at Bigwin.

The dates for the Summer Convention have been established to fit into school and college programs. The work in most schools and colleges closes before June 15, making it possible for parents with children in school and those engaged in educational work to get away. Many will find it possible to make the week of June 17 a vacation week, and where could it be better spent than in Canada attending the A.S.H.&V.E. Convention? Here you will find a combination of work and play designed to please everyone and here you will renew acquaintances, meet old friends and make new ones.

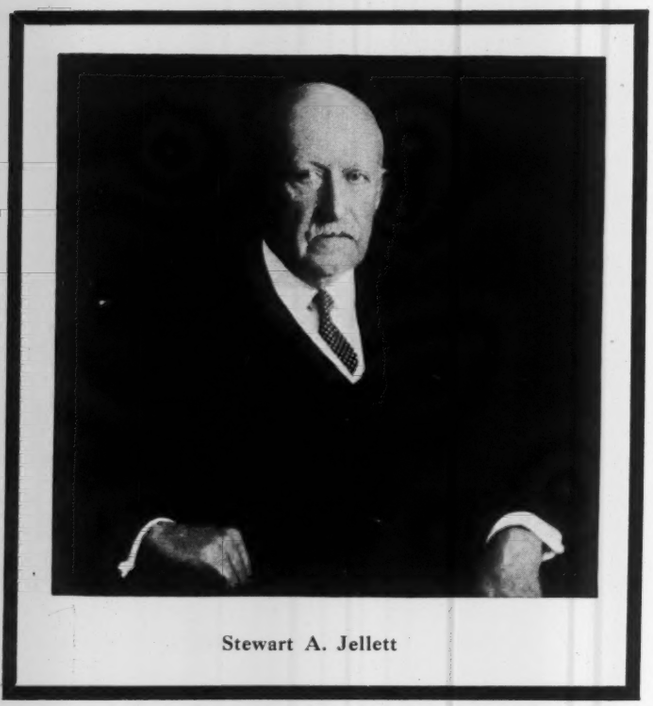
The Ontario Chapter promises that you will enjoy attendance at the Summer Meeting this year. If you do not attend they will have the disappointment and you the regret.

Make your plans to be in *TORONTO, CANADA,* June 17-19.

John Leonard President,

May 1, 1935.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.



Stewart A. Jellett

Death of Stewart A. Jellett

ON April 5, 1935, Stewart A. Jellett, Charter Member, Presidential Member and Honorary Member of the Society, died at his home in Philadelphia at the age of 73, after a lingering illness, and was buried in Ivy Hill Cemetery on April 8, in the presence of his many friends and a sorrowing family group consisting of his wife, Catherine, three sons, Stewart A., Jr., Roland T. and Joseph M., and a daughter, Theodora.

Messages of sympathy were sent by the Officers and Council and suitable floral tributes came from the Society, the Advisory Council and Philadelphia Chapter and official representatives of these groups attended the funeral services.

Stewart A. Jellett was a pioneer in heating and ventilating engineering and was one of the few privileged to live long enough to realize and enjoy the great developments which occurred in this field during the last half century. In 1879, at the age of 17, he was indentured to learn the trade of engine turning on watch cases and upon the termination of this apprenticeship he served for two years as assistant foreman before entering the field of heating and ventilating. From 1885 until illness prevented he was a recognized leader in his chosen profession. As draftsman and engineer with the Philadelphia Exhaust Ventilator Co., he designed and supervised the construction of systems of drying for many commonly used products such as soap, glue, leather, paper, lumber, bricks, cotton and wool. After two years he became a partner in the business and the scope of the company's work was enlarged to include heating and ventilating, as well as drying.

It was at this period of Mr. Jellett's career that he did pioneer work in two fields, namely ship ventilation and steam heating. He was responsible for the design of the complete mechanical ventilation equipment for the cruiser, Yorktown, built for the U. S. Navy by William Cramp Shipbuilding Co. When the Drexel Building was built in Philadelphia in 1887, a down feed system of exhaust steam radiator supply piping was used and was one of the first of its kind.

From 1889 to 1912 Mr. Jellett was successively Engineer, Manager, Vice-President and Treasurer for Francis Bros. & Jellett Inc., during which time he had charge of all engineering design and construction which included such important work as the Philadelphia Bourse Bldg., numerous buildings at the University of Pennsylvania and at Bryn Mawr College, a number of hotels and institutional buildings in New York City, and Carnegie Libraries in Denver and several other cities.

From 1912 until his death Mr. Jellett was President of the Stewart A. Jellett Co. and was responsible for the design and installation of a great many heating, ventilation and electric generating plants.

Mr. Jellett was a pioneer in the field of fire prevention and in 1917 he was appointed a member of the Committee on Fire Prevention and Insurance of the Philadelphia Chamber of Commerce and served as Chairman of the Committee from 1920 to 1925. From 1925 until 1934, when he resigned, Mr. Jellett was a member of the Board of Directors of the Philadelphia Chamber of Commerce.

He was an active member of the *Heating, Piping and Air Conditioning Contractors' National Association* and in 1900 served as a Director, became President in 1901 and in 1902 and 1903 was Chairman of the Board of Directors. He served on many important committees between 1903 and 1907, devoted 7 years to the work of the Committee on Standards and served as President of the Old Guard in 1924. He was a charter member of the *Philadelphia Association* serving as Secretary at the time of organization in 1889 and held every office in the organization. Mr. Jellett was an organizer and first President of the *Germantown and Chestnut Hill Improvement Association* and held membership in the Bankers, Union League, Manufacturers, and the Philadelphia Cricket Club.

To the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Mr. Jellett rendered distinguished service as President in 1895, as Secretary in 1898, as Chairman of the Board of Managers in 1899 and as a member of the Board of Managers from 1895 to 1899.

He was a Charter Member of the Society and was one of a small group of men who met in 1894, to organize the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS. The first regular meeting held at the Broadway Central Hotel in New York, September 10, 1894, recorded a charter membership of 75 at which Officers were elected to serve until January, 1895, when

the first Annual Meeting of the Society was held at 12 West 31st St., New York, January 22 to 24, at which Pres. E. P. Bates, Syracuse, N. Y., presided. During this meeting Mr. Jellett was elected President of the Society and in his acknowledgment of the honor conferred upon him said, "I believe there is a field for a Society of this kind in this country . . . and I feel that it wants to be considered entirely from an engineering standpoint; that we want to consider means and methods for the development of the business of engineering both for heating and ventilating buildings in the different methods employed today and in the improvement of those methods. Anything that we can do in the way of improving the science of heating and ventilation contributes so much to the public welfare and the public health and it is an ennobling work to which all of us should lend our best efforts aside from any business consideration." Those ideals of service and cooperation were typical of the life of Stewart A. Jellett, of whom it might well be said:

"From which unselfish start,
Let those who follow ne'er depart."

Local Chapter Reports

Illinois

April 8, 1935. All attendance records of the Illinois Chapter were broken when 276 members and guests assembled for this interesting meeting. Dinner was served at 6:45 p.m. and the meeting was called to order at 8:05 p.m. by Pres. R. E. Hattis.

Due to the lengthy program, the reading of the minutes of the March meeting was dispensed with by vote. The Chapter Secretary, L. S. Ries, who had been unable to be present since his election, was welcomed back to his Chapter activities.

President Hattis next presented a certificate of Life Membership in the A.S.H.V.E. to R. H. Thomas. Mr. Thomas, in his speech of acceptance, told many interesting incidents of his early experiences in heating and ventilating work.

Acting Secy. J. J. Hayes read Pres. John Howatt's monthly letter to the Chapter and several letters from Secy. A. V. Hutchinson.

C. E. Price announced the golf program for the coming summer of the *Western Trade Golf Association.* He called special attention to the tournament on June 13 at Bob-O-Link, to which all A.S.H.V.E. members are invited.

S. R. Lewis was then introduced as chairman of the evening meeting. Before Mr. Lewis opened the program, he told the Chapter of the recent death of S. A. Jellett, who was president of the A.S.H.V.E. in 1895.

Mr. Lewis presented for general discussion, section by section, Standards for Certified Air Conditioning for Comfort, prepared by the cooperative efforts of the Consulting Engineers Division of the *Western Society of Engineers,* the *Chicago Master Steam Fitters' Association,* and the *Ventilating and Air Conditioning Contractors' Association.* He stated that the standards are very much needed for the good of the industry and suggested that any mistakes the Committee may have made can be corrected.

It was apparent early in the evening that a considerable amount of discussion would follow the reading of each section. This discussion included remarks by Messrs. Aeberly, Factor, Harbula, Hart, Hattis, Hill, Brooke, Sutcliffe, Hoier, and a great many others. H. M. Hart explained in detail the purpose of Certified Air Conditioning for Comfort.

The outcome of the meeting was the following resolution, which was proposed by J. J. Aeberly, seconded by A. G. Sutcliffe, and passed by unanimous vote of the Illinois Chapter members: It is the consensus of the Illinois Chapter members that the Committee, of which S. R. Lewis is chairman, has done a good piece of work; that the Standards for Certified Air Conditioning for Comfort be endorsed in general, calling to the attention of the Committee the fact that some of the premises are subject to change as established advances occur; and that the Standards be accepted as written until such time as knowledge is more complete.

The meeting adjourned at 10:40 p.m.

Michigan

April 1, 1935. The April meeting of the Michigan Chapter was held at the Wardell Hotel, when approximately 80 members and guests were present for dinner and 125 attended the meeting.

After roll call, Pres. G. D. Winans appointed the following as members of the Nominating Committee: J. F. McIntire, *Chairman;* H. E. Paetz and R. S. M. Wilde.

Prof. A. P. Kratz, of the University of Illinois, was the first speaker of the evening and was introduced by President Winans. Professor Kratz spoke on the Summer Cooling Project in the Research Residence at the University of Illinois and demonstrated his talk with slides. He also gave a summary of tests which had been made and the resulting conclusions.

G. B. Helmrich was the second speaker and gave a similar talk on tests being conducted in a Birmingham residence by the Detroit Edison Co. He also summarized tests and conclusions.

A general discussion followed these two presentations and Secy. W. F. Arnoldy reports that the meeting adjourned at 10:30 p.m.

Western Michigan

April 8, 1935. Dinner was served at 7:00 p.m. to 15 members and 34 guests of the Western Michigan Chapter, who assembled at the Community House, Parchment, Mich.

Following dinner, Pres. S. H. Downs introduced R. B. Hayward, who described the many heating and ventilating problems encountered in paper mills.

Short talks were also given by A. N. Petersen on a new power plant installation, and by R. S. Clark and C. R. Gibbs.

A brief business meeting followed with minutes of the previous meeting read by Secy. W. G. Schlichting and approved.

President Downs called for a report of the Nominating Committee, comprised of W. W. Bradfield, J. J. Troske, and K. L. Ziesse. Mr. Bradfield reported the following nominations for Chapter officers:

President—P. O. Wierenga.
Vice-President—L. G. Miller.
Secretary—J. J. Troske.
Treasurer—H. F. Reid.
Board of Governors—O. D. Marshall, S. H. Downs, D. L. Taze.

A short discussion occurred regarding a suitable place to hold the annual meeting in May. Acting upon motion presented by Mr. Bradfield and seconded by Mr. Marshall, the Chapter voted to leave the matter entirely to the Program Committee.

Members and guests were then taken on a trip through the mill of the Kalamazoo Vegetable Parchment Co., which proved very interesting.

March 11, 1935. Twelve members and 39 guests of the Western Michigan Chapter were present for the dinner and meeting held at the Occidental Hotel, Muskegon, Mich.

Pres. S. H. Downs called the meeting to order and minutes of the previous meeting were read and approved.

A message to the Chapter from John Howatt, Chicago, Ill., president of the A.S.H.V.E., was read.

There being no further business, President Downs introduced F. M. Young and Ernest Witzel, Racine, Wis., who described the construction features and application of heat transfer surface as used in heating, cooling and air conditioning equipment.

This meeting, which adjourned at 11:00 p.m., was highly enjoyed by all those who attended, according to the report of Secy. W. G. Schlichting.

Minnesota

March 18, 1935. Members of the Minnesota Chapter were honored in having John Howatt, Chicago, Ill., President of the A.S.H.V.E., as their guest speaker. Minnesotans take just pride in saluting an alumnus of their own university as President of the Society.

The meeting was called to order by Vice-Pres. C. E. Gausman and the minutes of the previous meeting were read and approved. The secretary, R. E. Backstrom, read President Howatt's March Chapter letter.

Prof. F. B. Rowley introduced President Howatt, who spoke on the subject of Where We Are.

President Howatt began his talk with a brief mention of Government's part in business, since that factor must be considered in any discussion of its present status. Speaking of codes, Mr. Howatt stated that in his opinion one of the main benefits of NRA has been the contact with fellow members in industry. He expressed the thought that manufacturers soon learned that their competitors had the same interests and that codes, therefore, have aided in developing a better understanding of each other's problems.

President Howatt spoke at greater length regarding air conditioning and outlined some of the many possibilities for that industry. He mentioned the three fields for air conditioning, namely: comfort, industrial processes, and health. The need for a clear and definite understanding among engineers, architects, and contractors of the benefits of air conditioning was emphasized. President Howatt urged the Chapter to take an active part in promoting among State and local authorities the passage of codes and definitions covering all phases of the subject. He felt that such codes would go far toward clearing the confusion that exists at present and he cited instances in which wide variation in bids on air conditioning equipment occurred due to lack of understanding of requirements.

Members were asked to consider seriously the possibilities of air conditioning for health and to aid in obtaining recognition for the Society in every field of the industry.

Classmates of President Howatt who especially enjoyed the evening and the opportunity of talking over old times were R. W. Otto, Fred Otto, and E. W. Johnston. Among the 80 members and guests present were six of the 36 new student members from the University of Minnesota. Members recently elected to the Society were introduced by Professor Rowley.

The Chapter feels deeply grateful to President Howatt and extends a warm invitation to him to return to Minnesota at his earliest opportunity.

New York

April 15, 1935. Over 60 members and guests attended the April meeting of the New York Chapter at the Building Trades Club. The meeting was featured by the presence of the national president of the A.S.H.V.E., John Howatt, Chicago, Ill.; a proposal by W. L. Fleisher, chairman of the Finance Committee of the Committee on Research; by the annual election of Chapter officers; and by the presentation of a life membership certificate to T. E. Crone.

President Howatt presented the engraved certificate and Mr. Crone responded with entertaining stories of his early experiences.

In his address, President Howatt, who has been visiting A.S.H.V.E. Chapters, laid emphasis on heating, ventilating and air conditioning work in school buildings, with which practice he is especially familiar because of his position as chief engineer of the Chicago Board of Education. He expressed the opinion that there would be a substantial increase in the number of new school buildings constructed, rather than a decrease. He outlined his ideas of air conditioning and proposed that the Society and its Chapters take active steps to set up appropriate standards of practice. President Howatt also called special attention to the rising interest in air conditioning from the standpoint of health.

Mr. Fleisher proposed that the Society accept a new viewpoint regarding the scope of its membership and the method whereby its research activities should be financed. He outlined his ideas specifically by proposing that membership be greatly broadened and that an attempt be made to set up a substantial endowment fund, initially not less than $1,000,000 to support research on the relation of air conditioning to well-being.

The regularly nominated slate of officers for 1935-36 was duly elected. The new officers are:

President—W. W. Timmis.
Vice-President—G. E. Olsen.
Secretary—T. W. Reynolds.
Treasurer—W. M. Heebner.
Board of Governors—H. W. Fiedler, A. F. Hinrichsen, W. E. Heibel.

Western New York

April 9, 1935. The April dinner and meeting of the Western New York Chapter was held at the Touraine Hotel, with Pres. John Howatt of the A.S.H.V.E. as guest of honor and speaker. Thirty-eight members and guests were present for the dinner.

Pres. W. E. Voisinet called the meeting to order and a motion to suspend the regular order of business was passed unanimously. President Voisinet, with appropriate compliment to the speaker, introduced President Howatt, whose topic was Our Position Today.

In his preliminary remarks, President Howatt outlined the present status of building and construction with respect to comparative volume and economic conditions. He then discussed the true definition of air conditioning and stressed three phases of it: for comfort; for industrial processes; and for health. In conclusion President Howatt outlined a three-point plan for future attainment: to establish definite standards of air conditioning, which will be understood and accepted not only by the engineer, but also by the public; to stress and advance to the public the health and comfort possibilities of air conditioning; to strive for the general recognition of the Society and its work.

The fifty-two members and guests attending the meeting then expressed their appreciation to President Howatt for his splendid talk with a rising vote of thanks.

The meeting was then turned over to Vice-Pres. B. C. Candee, who conducted the discussion period and carried the meeting through to adjournment, according to the report of Secy. J. J. Landers.

March 11, 1935. Pres. W. E. Voisinet presided at the March meeting of the Western New York Chapter held at the Touraine Hotel with an attendance of 20 for dinner and 32 for the meeting.

The March letter on Research by Pres. John Howatt was read and M. C. Beman made special reference to the facilities available for members at the Research Laboratory of the A.S.H.V.E. for information concerning publications in the field of thermal research and progress on research work being made by others in heating, ventilating and air conditioning.

A resolution, which was adopted at the 41st Annual Meeting in Buffalo in January, was read and expressed thanks to the Western New York Chapter for their hospitality.

Vice-Pres. P. S. Hedley, who had been nominated for Trustee of the Village of Kenmore, received the best wishes of the members present for a successful political campaign.

The Public Utility Holding Company legislation before Congress was discussed and was referred to D. J. Mahoney for a report.

B. C. Candee, treasurer, presented his annual report, which

showed a very satisfactory bank balance, indicating the best financial condition in the history of the Chapter.

Mr. Beman advised that the new Chapter Constitution would be ready for submission to members at the April meeting.

L. P. Saunders was the speaker of the evening and was introduced by President Voisinet. Discussing the subject of Radiator Development, Mr. Saunders traced in a very interesting way the evolution of heat dissipation methods on automobiles from the original crude design to the current models. The subject was further elaborated with lantern slides showing an ingenious test tunnel. Several actual samples of radiator cores were also displayed. At the conclusion Mr. Saunders very ably answered many interesting questions and he was accorded a rising vote of thanks for his splendid talk.

The attention of the members was called to the fact that President Howatt of the A.S.H.V.E. would visit the Chapter on April 9 and speak on Our Position Today. A large attendance is anticipated.

Ontario

April 8, 1935. Forty-four members and guests were present at the regular meeting of the Ontario Chapter held at the Royal York Hotel. Following dinner, Pres. W. R. Blackhall announced that E. T. Whittall, *Chairman,* and M. B. Watson would act as auditors for the Chapter's financial statement to be reported at the May meeting.

J. S. Paterson introduced Prof. Robert Angus, head of the Mechanical School of the University of Toronto, who gave a very interesting address on Preparing Men for the Engineering Profession.

A vote of thanks to Professor Angus for his splendid talk was extended by M. F. Thomas.

M. W. Shears was then called upon to read President John Howatt's monthly letter, which was entitled Membership.

E. H. Gurney introduced the principal speaker of the evening, President Howatt, Chicago, Ill., who gave a splendid address on Our Position Today. President Howatt emphasized the importance of establishing air conditioning standards, and asked the Ontario Chapter to sponsor activities along these lines.

Before the meeting adjourned, L. L. Anthes extended a vote of thanks to President Howatt for visiting the Ontario Chapter and for his instructive address.

Philadelphia

April 11, 1935. Pres. J. H. Hucker called the meeting to order at 8:30 p.m., after a delightful dinner at the Engineers Club.

Major Wm. Spatig of the Salvation Army appealed to members of the Chapter for support of their work in Philadelphia.

President Hucker called upon Mr. Cassell, chairman of the Committee consisting of H. P. Gant, F. D. Mensing, and J. D. Cassell to present a memorial resolution on the death of S. A. Jellett, Sr. President Hucker then asked for a moment of silent prayer in memory of Mr. Jellett. A motion was then duly made and seconded that a copy of the memorial resolution be spread upon the minutes, and the Secretary instructed to send a copy to the members of Mr. Jellett's family.

The minutes of the previous meeting and the Treasurer's report were read and approved.

R. F. Hunger reported on the membership drive, stating that two new members had been secured.

President Hucker then introduced M. F. Blankin as toastmaster, who in turn presented the following past presidents of the Philadelphia Chapter: L. C. Davidson, H. G. Black, R. E. Jones, R. C. Bolsinger, F. D. Mensing, J. D. Cassell, H. P. Gant, C. V. Haynes, and Harry Harrison of the *A.S.R.E.*

Secy. A. V. Hutchinson was introduced and read Pres. John Howatt's April letter to Chapters.

Mr. Blankin presented the president of the *A.S.H.V.E.,* John Howatt, Chicago, Ill., whose very interesting and enlightening talk was exceptionally well received. President Howatt's address was inspiring and a real treat to the Philadelphia members present.

Chairman A. C. Caldwell was called upon by Mr. Blankin and reported on the May meeting and outing.

W. R. Eichberg spoke briefly on the Society's value to its members.

The meeting was turned back to President Hucker, who adjourned it at 10:00 p.m., according to the report of H. H. Erickson, Secretary of the Chapter.

March 14, 1935. Pres. J. H. Hucker called the meeting to order at 8:30 p.m. and the minutes of the previous meeting and the treasurer's report were read and approved.

Secy. H. H. Erickson announced the appointment of members to serve on committees and several reports were made. A. H. MacDade remarked on the excellent attendance and A. E. Kriebel told of the progress of the Year Book Committee. The chairman of the Membership Committee, R. F. Hunger, reported on the membership drive, which showed that an excellent start had been made. Five new members were elected to the Philadelphia Chapter. Mr. Hunger also made an announcement concerning the rate of Society dues for 1935.

Pres. John Howatt's very interesting monthly letter was read and well received.

H. G. Black reported on the Questionnaire concerning unemployment.

J. D. Cassell explained fully the action of the Council on reinstatement applications for membership.

At the suggestion of Mr. Cassell the Chapter voted to go on record in favor of having a majority vote of the Committee on Admission and Advancement prevail in the classification of membership.

Mr. Cassell also spoke on the advisability of changing the regulations of the Society's Constitution and By-Laws applying to the Nominating Committee, and expressed the view that the Committee was too large. Action on this was referred to the Board of Governors.

A. C. Caldwell introduced the speaker of the evening, R. E. Jones, whose talk on Fuel Oil, followed by the showing of a talking picture, depicted some phases of the gasoline industry and was very well received. A rising vote of thanks was given to Mr. Jones.

The meeting was then turned back to President Hucker, and, on motion, adjourned.

February 14, 1935. Pres. J. H. Hucker called the meeting to order at 8:20 p.m. after dinner at the Engineers Club. The minutes of the previous meeting and the treasurer's report were read and approved.

President Hucker announced that the resignation of E. N. Sanbern as treasurer and the election of L. P. Hynes to fill the vacancy had been approved.

The Council's approval of the amendments to the Constitution and By-Laws of the Philadelphia Chapter was announced by President Hucker, who also told of the appointment of Miss A. E. Schmidt as corresponding secretary and bookkeeper.

A letter was read from Pres. John Howatt, of the A.S.H.V.E., in which he extended his greetings to the members of the Philadelphia Chapter and emphasized the interest and enthusiasm exhibited at the Annual Meeting in Buffalo.

A report on the questionnaire which was sent to Chapter members, was given by H. G. Black. The return was gratifying, particularly the first returns which showed 18 replies, all employed, and in four cases advised that additional employees would soon be required. Ten checks for dues were returned with questionnaires.

The importance of increasing the membership was stressed in a talk by President Hucker.

J. D. Cassell was called upon to give Chapter members a resumé of what happened at the Annual Meeting in Buffalo. Mr. Cassell gave some interesting sidelights on the meeting and pleaded for the cooperation of members in building up the Chap-

ter to a point where it was five years ago. He emphasized the value of Society membership to the individual.

F. D. Mensing spoke on the importance and desirability of the Questionnaire, and suggested an addition, "Are you satisfied with your job?" He asked that members endeavor to find better jobs for others and help them build up their incomes. He urged that Mr. Black be used as a clearing house for employment and advancement of members.

A campaign for new members was outlined in an interesting manner by R. F. Hunger, who announced his appointment of 12 captains and teams, explaining his system of "point credits."

Mr. Cassell announced that the Council greatly regretted the dropping of 16 members of the Chapter for non-payment of dues, and strongly urged their reinstatement at an early date.

The chairman of the Year Book Committee, A. E. Kriebel, discussed the importance of publishing a Chapter Year Book for 1935.

President Hucker announced the receipt of a report of a committee appointed by the State Council of Education to study the problems of heating and ventilating of school buildings. Upon the request of the State Council for suggestions and criticisms of the report, the following committee was appointed to investigate and report: A. J. Nesbitt, *Chairman,* H. F. Rettew, A. E. Dambly, and Benjamin Adams.

C. V. Haynes delivered a eulogy on A. C. Edgar, Past President and Charter Member of the Philadelphia Chapter, upon the anniversary of his death, and read a letter suggesting that a memorial be erected and expressed the thought that the Chapter contribute to the memorial.

Mr. Haynes also thanked the Chapter members for their support and cooperation while he was president of the Society in 1934.

Mr. Hucker told of the contribution of the Philadelphia Chapter to the memorial for Mr. Edgar.

The meeting was then turned over to A. C. Caldwell, Chairman of the Meetings Committee, who read a letter of thanks received from the Germantown Boys Club.

Mr. Caldwell called upon Mr. Hynes, who showed slides in the interest of securing new members for the Engineers Club.

Mr. Caldwell then asked Morris Sheffler to introduce the speaker of the evening. H. L. Galson, development engineer, was presented and discussed Air Conditioning Units Embodying Cooling and Heating by Refrigeration. A rising vote of thanks was given to Mr. Galson.

The meeting was then turned back to President Hucker and adjourned at 10:30 p.m.

Pittsburgh

March 11, 1935. Pres. L. B. Pittock called the meeting to order in the auditorium of the U. S. Bureau of Mines at 7:45 p.m. The minutes of the previous meeting were read and approved with correction.

J. F. S. Collins, Jr., of the Program Committee, reported that the April meeting had been reserved for a discussion of the Proposed Ventilation Code for the State of Pennsylvania.

E. C. Smyers, Membership Committee, stated that a few candidates were considering applying for membership.

F. C. McIntosh told of several questions which had recently come up before the Council for action.

Secy. T. F. Rockwell read two of Pres. John Howatt's letters to Chapters.

President Pittock reappointed P. A. Edwards, *chairman,* G. S. McEllroy, and E. S. Tower as a committee to represent the Pittsburgh Chapter at meetings of the Joint Committee of Construction Agencies of Western Pennsylvania.

A motion was made and carried that the president appoint a representative to the meeting of the *Pittsburgh Affiliated Technical Societies* for the purpose of electing officers for the coming year.

It was also moved and carried that the president appoint a committee to review the Proposed Ventilation Code for Pennsylvania and present a report at the April meeting of the Chapter.

After discussion it was decided to continue meeting at the same place and time for the remainder of the season.

President Pittock introduced G. S. McEllroy, consulting engineer, who spoke on The Fundamentals of Air Conditioning. In his paper, Mr. McEllroy reviewed the Laws of Boyle, Charles, and Dalton, demonstrating the partial pressures of mechanical mixtures of gases by means of a mercury barometer tube.

Three prepared discussions were presented following the formal paper.

F. C. Houghten, director of the A.S.H.V.E. Research Laboratory, briefly reviewed the laboratory work in investigating the physiological effect of changes in air surrounding the body.

F. C. McIntosh discussed the possibility of standardizing on one form of psychrometric chart.

Prof. C. M. Humphreys discussed the misapplication of air conditioning terminology.

President Pittock then introduced M. G. Harbula, Chicago, Ill., who related some of his experiences in design. Mr. Harbula also suggested that the local chapters send improved definitions of the term, air conditioning, to the headquarters office.

The technical program closed at 9:50 p.m., after which the Program Committee offered two reels of motion pictures of Glacier National Park.

Seventy-two members and guests attended the meeting.

St. Louis

March 6, 1935. Pres. John Howatt, of A.S.H.V.E., was the guest and speaker at the March meeting of the St. Louis Chapter. The meeting was held at the Kingsway Hotel and was called to order by Vice-Pres. C. R. Davis, with an attendance of 25. The minutes of the February meeting were read and approved.

Secy. A. L. Walters read President Howatt's March letter on Research and a letter from A. V. Hutchinson, secretary, regarding the new amendments to the Constitution and By-Laws pertaining to membership.

L. W. Moon, Chairman of the Membership Committee, reported two new members since January 1 and other likely prospects.

The meeting was then turned over to President Howatt, who spoke on Our Position Today. In his talk, President Howatt gave special emphasis to the necessity for the establishment of definite standards of air conditioning and acquainting the public with them; also the necessity for bringing about a realization of the health properties of air conditioning.

Southern California

March 11, 1935. The President's Meeting of the Southern California Chapter began at 5:30 p.m., when approximately 125 members and guests assembled in front of the new Los Angeles Times Building to make a tour of inspection of the power plant and the mechanical equipment. From the Times Building, 75 members and guests proceeded to the Rosslyn Hotel for dinner, after which a meeting was held.

John Howatt of Chicago Ill., President of the A.S.H.V.E., was the speaker of the evening.

Secy. P. C. Scofield reports that the Chapter greatly enjoyed President Howatt's splendid talk and wishes to thank Mr. Howatt and the Society for the opportunity given to the Chapter to hear their president, who is so well informed and able to discuss the practical problems of engineers engaged in heating and ventilating.

February 19, 1935. The Southern California Chapter held its regular meeting at 6:30 p.m. in the Chamber of Commerce Building. Previous to the meeting an informal social hour was enjoyed by 60 members and guests.

Walter Bantau, engineer for the Fox West Coast Theatres, was the speaker, and gave a very interesting talk on the opera-

tion and maintenance of air conditioning systems. Some of the points discussed in his talk were the control of air conditioning systems, methods of air distribution in theatres, control of the PH value of water used in the air washers, and problems encountered with smoke exhaust since the passing of the ordinance allowing smoking in the balcony of many theatres.

Those present were given an opportunity to ask questions and have an informal discussion. The meeting adjourned at 8:30 p.m.

Wisconsin

March 19, 1935. The March meeting of the Wisconsin Chapter was called to order by Pres. Ernest Szekely and on this occasion Pres. John Howatt of the A.S.H.V.E., Chicago, Ill., was the guest of honor. The program was preceded by dinner at the Hotel Pfister with the largest attendance of the year.

The first matter of business was the reading of the minutes of the previous meeting, which were approved by those present. Secy. G. E. Hochstein then read President Howatt's March letter to Chapters on the subject of Research.

President Szekely called upon Prof. G. L. Larson, Madison, Wis., to introduce the principal speaker of the evening, Mr. Howatt. President Howatt's talk was considered one of the best heard in Milwaukee in a number of years and his discussion of the subject of Air Conditioning was thought of as a particularly fine presentation.

E. A. Jones gave a report on the Wisconsin Heating and Ventilating Code Revision.

C. H. Randolph told of the cooperative research work being done at Marquette University and announced that a paper on heat transfer would be presented at the April Chapter meeting.

The meeting was closed at 10:30 p.m.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 34 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by May 15, 1935, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	*REFERENCES*	
	Proposers	*Seconders*
BAUGHMAN, L. R., Supt. of Plbg. & Htg., Zion Inst. & Ind., Inc., Zion, Ill.	Lester Koetz	H. G. Kreissl
	J. R. Vernon	R. E. Moore
BUTTARAVOLI, FRANK, Student, Pratt Inst., Brooklyn, N. Y.	D. A. Fletcher *(Non-Member)*	L. B. Pope *(Non-Member)*
	F. O. Price *(Non-Member)*	J. L. Munson
CHROUCH, R. B., Grad. Student, Michigan State College, East Lansing, Mich.	B. F. McLouth	J. H. VanAlsburg
	L. G. Miller	S. H. Downs
CONATY, B. M., Sales Mgr., American Dist. Steam Co., N. Tonawanda, N. Y.	D. S. Boyden	M. C. Beman
	J. H. Walker	B. C. Candee
COOPER, A. W., Br. Mgr., Johnson Service Co., Los Angeles, Calif.	O. W. Ott	H. M. Hendrickson
	W. E. Barnum, Jr.	Leo Hungerford
COWARD, C. W., Pres. & Gen. Mgr., Coward Engrg. Co., Camden, N. J.	L. C. Davidson	R. F. Hunger
	C. B. Eastman	G. W. Barr
CUNNINGHAM, J. S., Student, University of Ill., Urbana, Ill.	A. P. Kratz	P. E. Mohn *(A.S.M.E.)*
	S. Konzo	W. H. Severns
ELLIS, G. P., Chief Engr., Board of Education, Pittsburgh, Pa.	F. C. McIntosh	A. J. Nesbitt
	John Howatt	J. D. Cassell
FOX, ERNEST, Asst. to Engr., C. A. Dunham Co., Ltd., Toronto, Ont., Can.	M. W. Shears	M. F. Thomas
	J. S. Paterson	W. P. Boddington
GILMORE, L. A., Vice-Pres., John Gilmore & Co., St. Louis, Mo. *(Advancement.)*	L. W. Moon	F. B. Fillo
	E. A. White	G. W. F. Myers
GORDON, W. D., Sales Engr., Tuttle & Bailey Co. of Can., Ltd., Fort Erie North, Ont., Can.	J. H. Van Alsburg	W. E. Fice *(Non-Member)*
	R. V. Millar	E. H. Gurney
GRABENSTEDER, LOUIS, Power Sales Engr., Union Gas & Elec. Co., Cincinnati, Ohio.	C. E. Hust	O. W. Motz
	W. C. Pistler	F. J. Ward
HAAS, R. B., Student, Mich. State College, East Lansing, Mich.	J. H. Van Alsburg	B. F. McLouth
	L. G. Miller	F. R. Bishop
HANKINS, R. P., Engr., G. A. Peple, Jr., Richmond, Va.	G. A. Peple, Jr. *(Non-Member)*	R. H. Shultz *(A.S.M.E.)*
	N. W. LaPrade, *(Non-Member)*	H. B. Hawkins *(Non-Member)*
HOPP, H. K., Student, Pratt Inst., Brooklyn, N. Y.	D. A. Fletcher *(Non-Member)*	L. B. Pope *(Non-Member)*
	F. O. Price *(Non-Member)*	J. L. Munson
JOHNSON, A. J., Director, Anthracite Inst. Lab., Primos, Del. Co., Pa.	H. H. Shaver	J. P. Gilboy
	L. W. Hildreth	E. W. Parker *(Non-Member)*
KAMPISH, N. S., Draftsman, Cooling & Air Conditioning Corp., New York, N. Y. *(Advancement.)*	J. W. Hunter *(Non-Member)*	H. S. Cameron *(Non-Member)*
	R. B. Dale *(Non-Member)*	W. J. Hargest *(Non-Member)*
KIRKPATRICK, A. H., Dist. Mgr., Ilg Electric Vtg. Co., Detroit, Mich. *(Advancement.)*	J. M. Frank	M. K. Arenberg
	A. G. Sutcliffe	H. J. Lagodzinski
KRIBS, C. L., JR., Consulting Mech. Engr., Kribs & Landauer, Consulting Engrs., Dallas, Texas.	W. H. Moler	I. I. Bock
	L. L. Landauer	T. M. Cunningham
LONG, W. E., Assoc. Prof. of Mech. Engr., Texas A. & M. College, College Station, Texas.	E. G. Smith	W. H. Badgett
	F. E. Giesecke	C. W. Crawford *(A.S.M.E.)*
MACHIN, D. W., Engr., Pittsburgh & Midway Coal Mining Co., Kansas City, Mo.	C. Y. Thomas *(A.S.M.E.)*	E. D. Hay *(A.S.M.E.)*
	L. A. Stephenson	A. H. Sluss
MARSHALL, W. D., Mgr., Htg. Dept., Noland Co., Inc., Washington, D. C.	C. V. Haynes	J. E. Axeman
	M. C. Gillett	A. V. Hutchinson

MAY, J. W., Instructor, University of Kentucky, Lexington, Ky.

MILLER, L. L., Student, Univ. of Minn., Minneapolis, Minn.

MOHRFELD, H. H., Engr., Collingswood, N. J.

MOORE, H. C., Instructor in Mech. Engrg., Mass. Inst. of Tech., Cambridge, Mass.

MUNSON, J. L., Instructor, Pratt Inst., Brooklyn, N. Y.

PAGE, ARVIN, Asst. Chief Engr., Bahnson Co., Winston-Salem, N. C.

PALMER, R. T., Patent Lawyer, Boston, Mass.

STEVENSON, M. J., Regional Engr., Frigidaire Corp., Dayton, Ohio.

TODD, S. W., JR., Sales Repr., American Radiator Co., Grand Rapids, Mich.

WEBSTER, W. H., JR., Field Engr., Hurst Htg. Engrs., Norfolk, Va.

WOLF, PHILIP, Pres., City Contracting Co., New York, N. Y.

WOLFF, P. P., Engr., Bell & Gossett Co., Chicago, Ill.

L. S. O'Bannon
C. C. Jett *(A.S.M.E.)*
F. B. Rowley
A. B. Algren
R. C. Bolsinger
A. H. MacDade
James Holt
C. W. Berry *(Non-Member)*
D. A. Fletcher *(Non-Member)*
F. O. Price *(Non-Member)*
F. F. Bahnson
M. E. Turner
A. C. Bartlett
L. H. Fitzberg
Carl Clegg
G. C. Morgan
D. L. Taze
W. W. Bradfield
Floyd Hurst *(Non-Member)*
E. B. Tazewell *(Non-Member)*
J. B. Kingsley *(Non-Member)*
F. W. Hanburger *(Non-Member)*
H. P. Reger
H. A. Lockhart

D. V. Terrell *(A.S.C.E.)*
E. A. Bureau *(A.I.E.E.)*
R. E. Backstrom
J. V. Martenis
W. P. Culbert
H. H. Erickson
C. L. Svenson *(Non-Member)*
T. H. Taft *(Non-Member)*
L. B. Pope *(Non-Member)*
D. A. Isenberg *(Non-Member)*
L. H. Plum
W. B. Hodge
J. F. G. Miller
R. E. Keyes
F. R. Still
G. H. Cummins
P. O. Wierenga
J. J. Troske
W. J. Powell *(Non-Member)*
H. S. Nowitsky
C. A. Walsh, Jr. *(Non-Member)*
H. L. Hosking

W. B. Graves
T. F. Hanley, Jr.

Candidates Elected

In past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

MEMBERS

BICHOWSKY, F. R., Mgr. Air Cond. Div., Surface Combustion Corp., Toledo, Ohio.

CHRISTOPHERSEN, A. E., Engr. Custodian, Board of Education, Chicago, Ill.

DEBOOS, F. A., Dist. Mgr., B. F. Sturtevant Co., Detroit, Mich.

ENSIGN, W. A., Vice Pres., Frontier Fuel Oil Corp. & Frontier Engrg. Corp., Lakeview, N. Y.

EVEREST, R. H., Sales Engr., Sheldons, Ltd., Galt, Ont.

FEELY, F. J., Mgr. of Sales, The Taylor Supply Co., Detroit, Mich. *(Advancement.)*

HILDRETH, L. W., N. Y. Mgr., Anthracite Inst., New York, N. Y.

HOWLETT, I. G., Consulting Engr., Howlett-Tauson Co., Oklahoma City, Okla. *(Advancement.)*

ILLIG, W. R., Owner, W. R. Illig Plbg. & Htg., Fitchburg, Mass. *(Reinstatement and Advancement.)*

KELLY, W. C., Field Engr., Iron Fireman Mfg. Co., Ltd., Toronto, Ont., Can.

KINGSLAND, G. D., Vice Pres., Minneapolis-Honeywell Reg. Co., Minneapolis, Minn.

RIVARD, M. M., Mfrs. Repr., Rivard Sales Co., Kansas City, Mo.

RUNKEL, CHARLES, Pres., Acme Htg. & Vtg. Co., Chicago, Ill.

SLUSS, A. H., Prof. Mech. & Ind. Engrg., University of Kansas, Lawrence, Kans.

SPENCER, J. B., Pres. & Chief Engr., Spencer Cooling & Air Cond. Co., Minneapolis, Minn.

TAUSON, P. O., Consulting Engr., Howlett-Tauson Co., Oklahoma City, Okla. *(Advancement.)*

TUCKER, L. A., Chief Engr., J. J. Pocock, Inc., Philadelphia, Pa.

ASSOCIATES

BLESSED, W. A., Mech. Engr., Mueller Brass Co., Port Huron, Mich. *(Reinstatement.)*

HARTON, A. J., Sales Engr., St. Jos. Ry. Lt. Ht. & Pr. Co., St. Joseph, Mo.

MCCRIMMON, A. M., Asst. Secy. & Controller, Hydro-Elec. Power Commission, Toronto, Ont., Can.

MIDDLETON, H. A., Proprietor, Middleton Elec. Co., Sedalia, Mo.

SEELERT, E. H., Factory Mgr., McQuay Inc., Minneapolis, Minn.

JUNIORS

AYERS, E. H., Supt., Healy Plbg. & Htg. Co., St. Paul, Minn.

BENSEN, C. L., Engr., McQuay Inc., Minneapolis, Minn.

CAWBY, E. L., Air Cond. Engr., Carrier Engrg. Corp., Newark, N. J.

CORRIGAN, J. A., Engr., Corrigan Co., St. Louis, Mo. *(Advancement.)*

ECKERT, E. K., Htg. & Air Cond. Engr., Holland Furnace Co., Knoxville, Tenn.

EDWARDS, H. B., Air Cond. Engr., Carrier Engrg. Corp., Newark, N. J.

GRAHAM, E. W., Air Cond. Engr., Carrier Engrg. Corp., Newark, N. J.

GRANSTON, R. O., Engr. & Estimator, University Plbg. & Htg. Co., Seattle, Wash. *(Advancement.)*

HAMIG, L. L., Sales Engr., Chrysler Air Cond. Div., Weber Implement & Auto Co., St. Louis, Mo.

HAYMAN, A. E., JR., Journeyman, Albert E. Hayman, Wilmington, Dela. *(Advancement.)*

HENSZEY, W. P., Junior Engr., Carrier Engrg. Corp., Philadelphia, Pa.

HOEHL, E. R., Air Cond. Engr., Carrier Engrg. Corp., Newark, N. J.

JORDAN, R. C., Charge of Air Cond. Dept., Central Supply Co., Minneapolis, Minn. *(Advancement.)*

KARTORIE, V. T., Grad. Asst. in Mech. Engrg., Case School of Applied Science, Cleveland, Ohio. *(Advancement.)*

KAUFMAN, C. W., Air Cond. Engr., Carrier Engrg. Corp., Newark, N. J.

MCGAUGHEY, J. E., JR., Air Cond. Engr., Carrier Engrg. Corp., New York, N. Y.

MCDOWELL, B. W., Air Cond. Engr., Carrier Engrg. Corp., Newark, N. J.

PAUL, L. O., Air Cond. Engr., Carrier Engrg. Corp., Chicago, Ill.

PRIESTER, G. B., Air Cond. Engr., Carrier Engrg. Corp., New York, N. Y. *(Advancement.)*

ROOS, E. B. J., Air Cond. Engr., Carrier Engrg. Corp., Newark, N. J.

SCHWANTES, A. R., Engr., 106 S. University Place, Beaver Dam, Wis.

WRIGHT, C. E., Part-time Instructor, Carnegie Inst. of Tech., Pittsburgh, Pa. *(Advancement.)*

STUDENTS

BARTON, D. H., Student, Agric. & Mech. College of Texas, College Station, Texas.

BURKS, R. H., Student, Agric. & Mech. College of Texas, College Station, Texas.

COCHRAN, W. B., Student, Agric. & Mech. College of Texas, College Station, Texas.

COTTER, R. P., Student, Agric. & Mech. College of Texas, College Station, Texas.

FITZGERALD, W. E., Student, Agric. & Mech. College of Texas, College Station, Texas.

HICKS, H. K., Student, Swarthmore College, Swarthmore, Pa.

JONES, A. P., Student, Agric. & Mech. College of Texas, College Station, Texas.

MONIER, K. A. J., Student, Agric. & Mech. College of Texas, College Station, Texas.

NOORD, D. F., Student, Carnegie Inst. of Tech., Pittsburgh, Pa.

RODGERS, W. C., Student, Agric. & Mech. College of Texas, College Station, Texas.

SCHUCANY, O. W., Student, Agric. & Mech. College of Texas, College Station, Texas.

STRINGFELLOW, J. C., Student, Agric. & Mech. College of Texas, College Station, Texas.

TEAL, E. T., Student, Agric. & Mech. College of Texas, College Station, Texas.

WARREN, C. W., Student, Agric. & Mech. College of Texas, College Station, Texas.

WEATHERBY, E. P., JR., Agric. & Mech. College of Texas, College Station, Texas.

WILSON, J. W., Student, Agric. & Mech. College of Texas, College Station, Texas.

WRIGHT, W. J., Senior Student, University of Ill., Urbana, Ill.

ZANGRILLI, A. J., Student, Carnegie Inst. of Tech., Pittsburgh, Pa.

In Fig. 106-A Jenkins puts this

EXTRA MEASURE OF QUALITY

that assures an extra measure of low-cost service

IN ONLY four years' time Jenkins Fig. 106-A has won an outstanding preference wherever Bronze Globe Valves are used. Valve-wise engineers and contractors demand it. And the men who pay the bills place their stamp of approval on a requisition for Jenkins Fig. 106-A, knowing that valves could be bought for less money.

Here, in pictures, are the reasons for Fig. 106-A's popularity. Study them for a minute. See the extra measure of quality that Jenkins puts into this valve. It is bound to make a visible difference in service ... a dollars and cents difference that should prompt you to specify "Jenkins Fig. 106-A" on your next order for Bronze Globe Valves.

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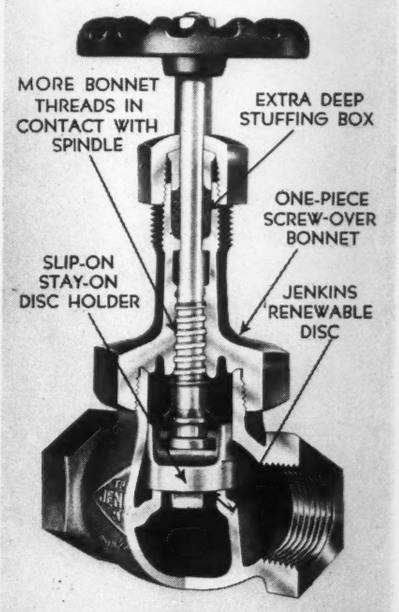
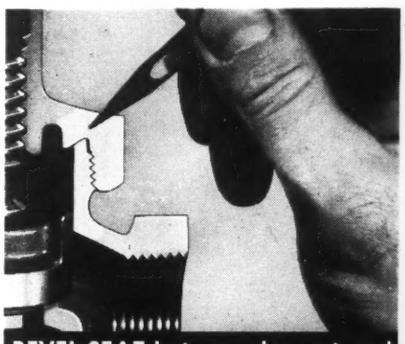
FIG. 106-A
Standard Bronze Globe Valve


MORE BONNET THREADS IN CONTACT WITH SPINDLE
EXTRA DEEP STUFFING BOX
ONE-PIECE SCREW-OVER BONNET
SLIP-ON STAY-ON DISC HOLDER
JENKINS RENEWABLE DISC

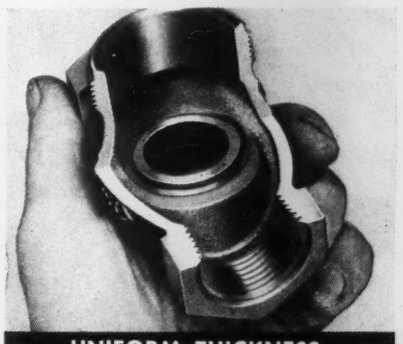


BEVEL SEAT between bonnet and body prevents body distortion when bonnet is tightened.

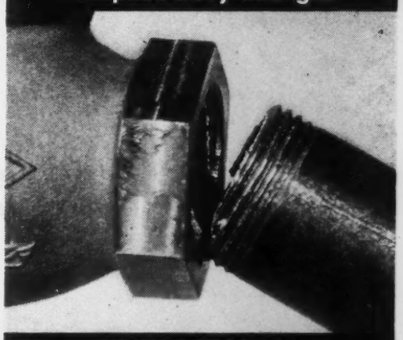
HIGH, WIDE SEAT permits more reseating operations and lengthens life of disc.

ADVANCED DESIGN FEATURES introduced by Jenkins Bros. four years ago.

CURVED DIAPHRAGM stronger to protect seat from distortion due to pipe strains.



UNIFORM THICKNESS and liberal use of finest metal multiplies body strength.



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Sound engineering practice backs up this selection. Wrought iron's record proves it longest-lasting, most economical for corrosive lines such as hot water, steam return and heating lines, underground lines, brine and other refrigeration lines, etc.

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Equipment Developments

For your convenience in obtaining more information about any of this equipment, see coupon on page 95

New Line of Air Conditioning Equipment

No. 308.—Sixty-three units, designed to meet every need from individual room conditioning to large theater and auditorium installations, make up the new Kelvinator air conditioning line.

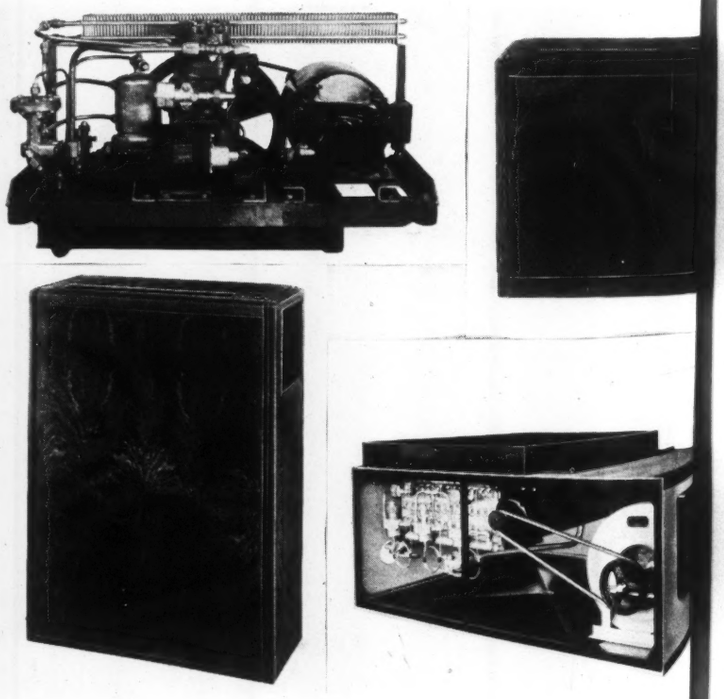
Seven self-contained cabinet types of units for offices, small shops and residence rooms have all the mechanism and controls enclosed and are ready to attach to drain, electric and water supply. Under average conditions these units are suitable for offices and rooms ranging from 160 to 440 sq ft in area, with average 10 ft ceilings. There are seven floor type cabinet models designed for use when the condensing unit can be located at some remote spot.

Four suspended type units equipped with temperature control are designed for installations where ceiling or recess location is desirable. These are adaptable to two-room installations where one suspended unit can be located in a closet or other space between the two rooms. Capacities range from two small bedrooms 12 by 18 by 8 ft to a small store or shop 42 by 20 by 12 ft. For larger requirements, there are eight additional suspended type units, four of them equipped with a special damper control. They also are made to operate from ceiling or recess locations and capacities range from shops of 30 by 20 by 12 ft to 50 by 30 by 12 ft.

Fifteen evaporator coils for duct installation, ranging in capacity from 1 to 20 tons, are available for larger installations where the refrigerating and conditioning equipment is located at some central spot and the conditioned air conveyed by ducts to the rooms and spaces to be conditioned. Down-draft air flow features the operation of these coils.

There are nine air cooled and thirteen water cooled condensing units, with capacities ranging from ⅓ to 20 hp.

The illustration shows (upper left) typical condensing unit; (upper right) floor type unit; (lower left) self-contained unit; (lower right) suspended unit.—Kelvinator Corp., 14250 Plymouth Rd., Detroit, Mich.



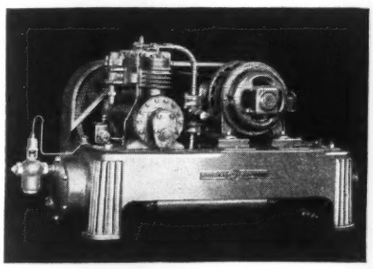
Timed Control for Apartment Oil Burners

No. 309.—A special device for timing oil burner operation is particularly adaptable to apartment buildings where different tenants must be satisfied. It is used in connection with a boiler limit control, connected in the line ahead of the timing device to insure safe boiler operation.

The device consists of a synchronous motor driving four cams. Three of these cams provide for different off and on periods of the oil burner and the fourth for a night off period. A four position snap switch is mounted on the side of the timer, three positions for selecting one of the operating cams, and the fourth for providing continuous operation except for the night off period. When connected, the timing motor runs continuously and operates the cam selected, thus providing the off and on operating periods desired. In this manner, selective operation is accomplished. —Struthers Dunn, Inc., 139 N. Juniper St., Philadelphia, Pa.

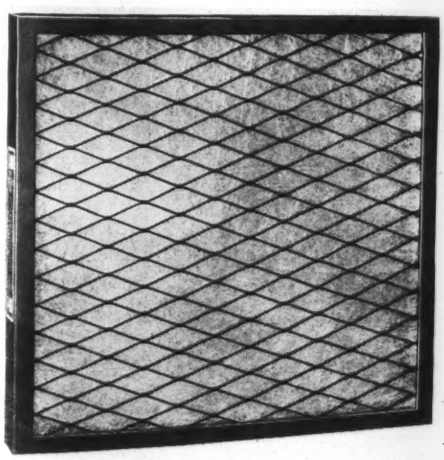
New Condensing Units for Air Conditioning

No. 310.—Eight new condensing units of from 1½ to 20 hp, rated at from 1.8 to 21.5 tons refrigerating capacity, have been announced. Three of them (Types CM-61S, CM-81W, and CM-81S) are equipped with water-cooled, double-tube counter-flow condensers, and the others (Type CM-81L, two Types CM-9L—illustrated—, and two Types CM-10L) have new shell-and-tube condenser receivers.



All have external motors with multiple V-belt drive to the compressors, liquid refrigerant filters, suction pressure controls, high-pressure safety lockouts, water regulating valves, service valves, and water and refrigerant connections. Units are shipped with a full charge of lubricating oil and a holding charge of freon. Included with each unit is a magnetic motor starting switch and a thermal overload protective device for the motor.

Feature of the "L" units is their shell-and-tube condenser-receivers which combine the functions of condenser and liquid receiver. Seamless steel water tubes are used in these units, galvanized against corrosion and providing straight accessible passages for cleaning. The tubes are finned on the refrigerant side for high heat transfer efficiency, and are of a size providing low pressure drop for cooling tower or city water service. Readily removable heads give quick access to the tubes for cleaning purposes, and the condenser assembly is capable of withstanding 2000 lb per sq in. pressure.—General Electric Co., Air Conditioning Dept., Schenectady, N. Y.



Improved Air Filter Units

No. 311.—New "Dustop" replacement type air filter is fire-resistant, lower in resistance, higher in efficiency, and life between replacements has been increased. Made up of a series of coarse and

TAYLOR FORGE WELDELLS

Better Installations because correctly engineered

● Engineers are watching installations more than ever before. Specifications are more accurately written. Material selection is based on previous service—that's why wrought iron is used for corrosive services. And that's why correctly engineered fittings are recognized as an essential part of all-welded systems.

Fittings must have tangents for accurate alignment—selective reinforcing for greater strength—ends beveled for neat welding—and smooth exterior and interior for high efficiency.

You get all of these *engineering* advantages plus the long life of wrought iron when you specify Taylor Forge Weldells made of Byers Wrought Iron Pipe. Write for suggested specifications, estimating prices and complete information.

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UNDERGROUND

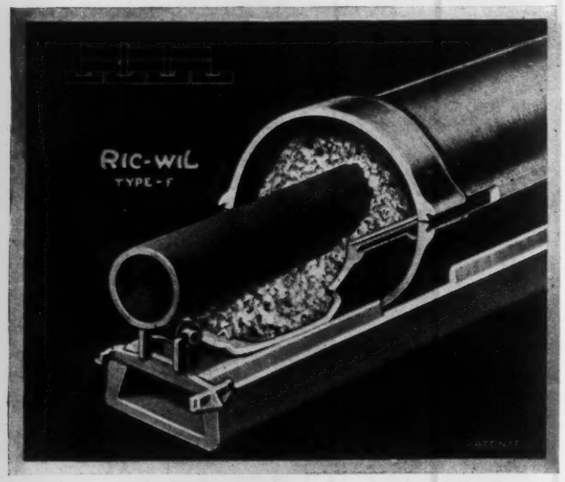
STEAM power costs can be reduced in some cases up to 25%, by the elimination of leakage in present underground lines—and by the prevention of such waste in new lines. Figures show that power costs run up to 10% of total manufacturing costs.

Likewise leakage and heat loss in underground steam heating lines can be tremendously curtailed, with consequent savings in fuel and operating costs. How?

The RIC-WIL Conduit System is certified for the highest known efficiency in the insulation and protection of underground steam lines. Made in a variety of types, materials, and insulating methods (including the famous waterproof asbestos RIC-WIL DRY-PAC), it secures satisfactory and economical results on *any* problem of underground steam transmission. Service is comprehensive in an engineering as well as manufacturing sense—from coast to coast. Write for details.

The RIC-WIL CO., 1562 Union Trust Bldg., Cleveland, Ohio
New York San Francisco Chicago
Agents in Principal Cities

On a recent large government job, officially tested, RIC-WIL Conduit showed 92% thermal efficiency.



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RIC-WIL

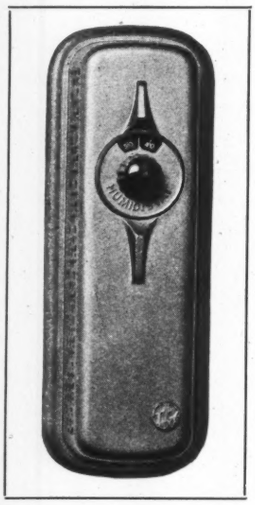
CONDUIT SYSTEMS FOR UNDERGROUND STEAM PIPES

fine mats of glass fibers bonded to each other to form a semi-rigid mat.

The dust and dirt catching adhesive has large dirt holding capacity and a surface tension four times that of engine oil, which means there is no oil vapor entrained in the air stream, says the maker. Air leaving the filter is odorless.—Owens-Illinois Glass Co., Industrial Materials Div., Toledo, Ohio.

Humidistats Improved

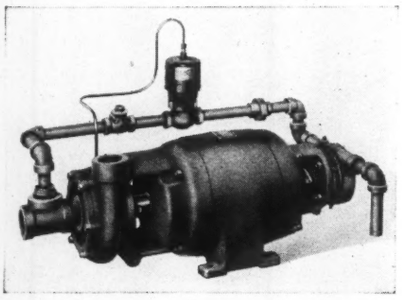
No. 312.—A new range of humidity controls has been designed to meet the exacting requirements of comfort and industrial air conditioning. These humidistats have specially prepared multiple human hair elements. Special attention has been given to providing handsome cases, finished on the "Alumilite" or anodized process, and proof against corrosion, even from alkaline, brine, acid, scratches, etc., according to the maker.



Control to within plus or minus 1 per cent relative humidity is possible. Setting is by bakelite knob, and rotating dial, and a range of from 10 to 100 per cent R. H. is provided.—Julien P. Friez & Sons, Inc., Baltimore, Md.

Self-Priming Pumping Units

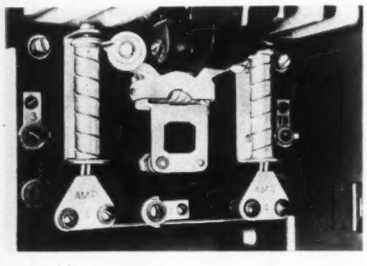
No. 313.—A new line of self-priming pumping units for general service is available for single or polyphase 50 or 60 cycle a-c as well as d-c, in capacities up to 400 gpm and total heads to 150 ft for the d-c and 60 cycle a-c types, and up to 300 gpm and 100 ft head for the 50 cycle a-c types.



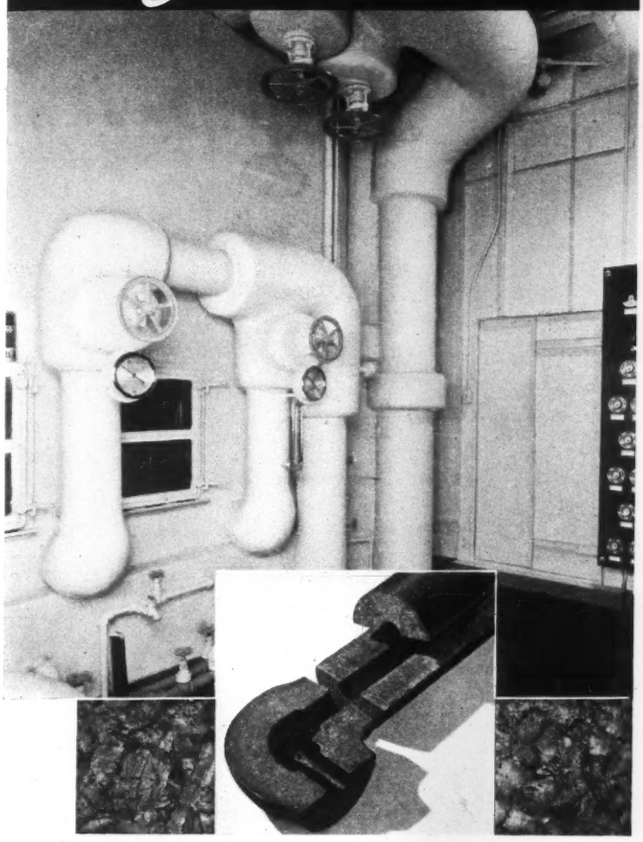
The positive primer is placed on the same shaft with the motor and pump. The only requirement is a reasonable tight suction line. When the pump is primed, a pressure operated cut-out automatically unloads the primer. There is no recirculation of water, no floats, or no valves to set, states the manufacturer.—Worthington Pump and Machinery Corp., Harrison, N. J.

New Motor Starters

No. 314.—New across the line type starters are for use with squirrel cage motors, or as a primary contactor for wound rotor (slip ring) motors in conjunction with suitable secondary rheostats. Features include automatic reset overload, manual reset overload operative from button in cover, start and stop push button in cover, handoff automatic switch and reset button in cover, and fusible or unfused disconnect switch. The thermal



MUNDET *Jointite* TRADE MARK CORK PRODUCTS



Mundet Pipe Line Insulation was specified for the air conditioning system of the Southern California Edison Co., Los Angeles—shown above.

• *For Permanent Efficiency*

"Jointite" Corkboard Insulation and Moulded Cork Pipe Covering have a place in the specifications wherever efficient, economical temperature control is required. The indispensable services that Mundet Cork products have performed for years in the refrigeration field are available to the air conditioning industry. The cork is finished in thinner sections, of course, since the services are not so severe—but it retains all of its high efficiency. It doesn't wear out, settle or warp—its service remains unimpaired year after year.

Send for our new catalogue, fully describing "Jointite" Cork Insulation, and giving information on Mundet Natural Cork Mats, for isolation of machine vibration.

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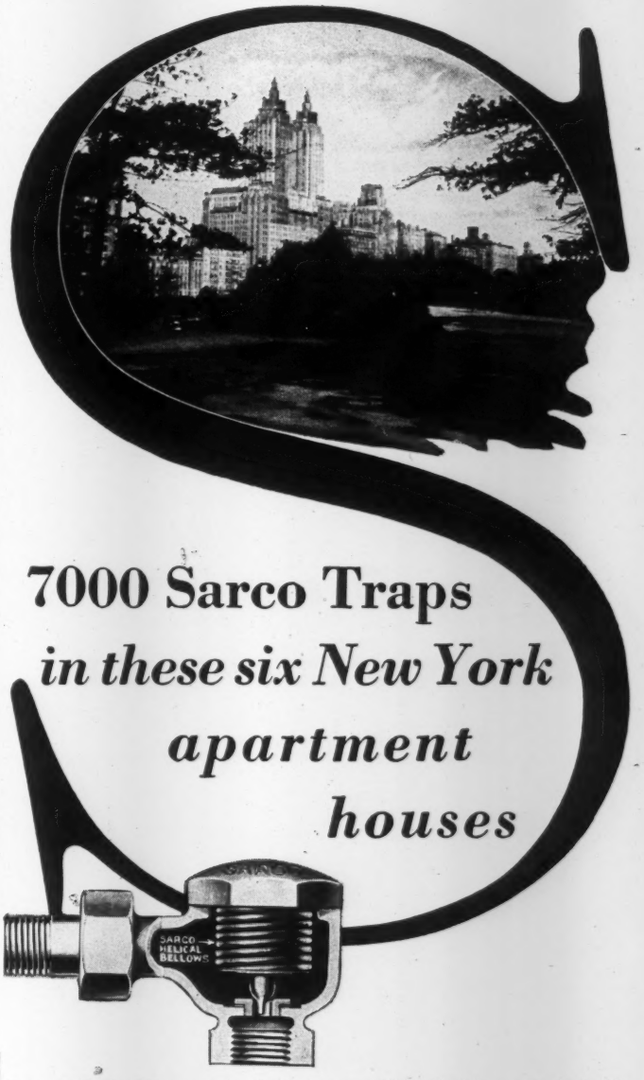

7000 Sarco Traps *in these six New York apartment houses*

Central Park West ranks high among New York's most desirable apartment locations. Our snap-shot, taken through Central Park, shows in the foreground the splendid El Dorado, flanked by five other fashionable apartment buildings.

All these buildings are equipped with Sarco Heating Systems, totaling more than 7,000 radiator traps.

Sarco Specialties for steam heating systems comprise Radiator Traps, Bellows-Packless Inlet Valves, Float-Thermostatic Traps for drips, Air Eliminators and Boiler Return Traps.

Leading architects and heating engineers specify them consistently for their QUALITY.

Remember Sarco also when modernizing heating systems. We can furnish replacement elements for rehabilitating radiator traps or valves of any make.

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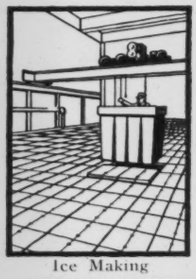
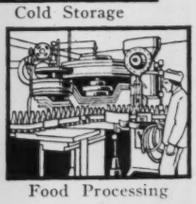
Architectural Work

Retailing


Ice Making

Test and Research

Cold Storage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Quick-Freezing

Transportation

Time was when "ice machines" were used only for brewery work, ice making, and cold storage. Today, Refrigeration will serve your clients in a dozen profitable ways, performing any of the following jobs:

Air conditioning
Cooling drinking water
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Keeping furs, flowers, candy, serums, etc.
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Sinking shafts in quick-sand
Quick-freezing fish, poultry, etc.
Drying motors, cable wire, powder, etc.

Let the nearest Frick man aid you in adapting Refrigeration, the New Tool of Industry and Business, to your particular problems. No obligation; but write, wire or phone NOW.

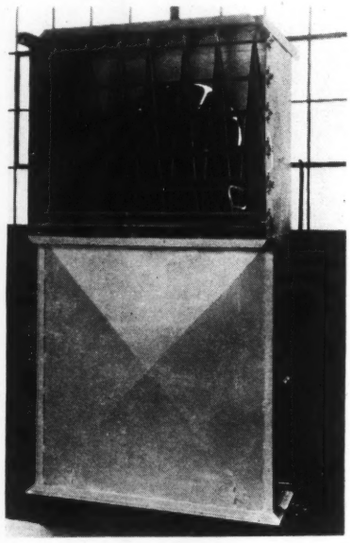
Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882

overload relay is so compensated as not to be affected by wide variations in ambient temperatures, says the manufacturer, and rating of the relay can be quickly changed by inserting the proper heater elements. The illustration is a close-up of the overload protective relay.

Enclosures are of pressed steel for general service, cast iron for dust-and water-tight service.—Monitor Controller Co., 51 S. Gay St., Baltimore, Md.

Unit Heater Designed to Prevent Stratification

No. 315.—In order to prevent stratification of high temperature air at the roof, and to promote distribution of warm air in the breathing zone, the "Faraday" unit heater handles two strata of air. Air from at or near the floor is drawn up through the stack or casing by natural draft and by induced action of the fan, the heater element being located near the bottom of the stack or



casing. The fan draws in air from the upper part of the building, which air mixes with the air drawn from floor level up through the stack or casing, the mixture being projected at high velocity. According to the maker, the tempered air is held in the breathing zone for a longer period of time and loss of heat through the roof or ceiling is reduced.

These units are made in floor, wall, and ceiling suspension types for gas or steam. The unit illustrated uses natural gas and has a capacity of 400,000 Btu. It is equipped with automatic safety pilot, electric valve and fan switch under thermostatic control. —Faraday Engrg. Co., St. Louis, Mo.

Fans Have Novel Features

No. 316—The duplex-rotation impeller-blower shown at the top of the illustration is applicable to the ventilation of industrial, commercial and residential buildings. It comprises a multiple disc fan unit; two fans rotate in opposite directions, one being mounted on the field of an electric motor and the other on the armature, the whole system being free to rotate around two bearings supporting the motor shaft. Current is supplied the motor field by slip rings. No gears or belts are used. The manufacturer points out that each impeller wheel runs at half the normal motor speed and therefore high speed motors may be used for lower fan speeds.

The fans are dimensioned and proportioned to eliminate rotational loss, states the maker, which produces high efficiency and gives high air delivery and static pressure at low rpm. The "Type A" is available in diameters from 8 in. to 10 ft, free delivery capacities from 760 cfm for the smallest size to 306,000 for the largest. Corresponding figures for "Type C" are 8 in. to 10 ft. 405 cfm to 187,000 cfm.

FRETZ-MOON PIPE

The standard for uniformity

There are two reasons for the high uniformity of Fretz-Moon Pipe. First, the steel skelp from which it is made is specially rolled from steel of evenly high quality. Second, the exclusive "continuous process" by which it is made takes advantage of the most modern methods of speed and temperature control and entirely eliminates guesswork and the possibility of variation in the product.

Because of these, Fretz-Moon Pipe possesses high degrees of uniformity, ductility and cleanliness not found in steel pipe made by ordinary methods.

The complete story of how Fretz-Moon Pipe is made and why it is better is contained in an illustrated booklet. Write for a copy.

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BLACK AND GALVANIZED

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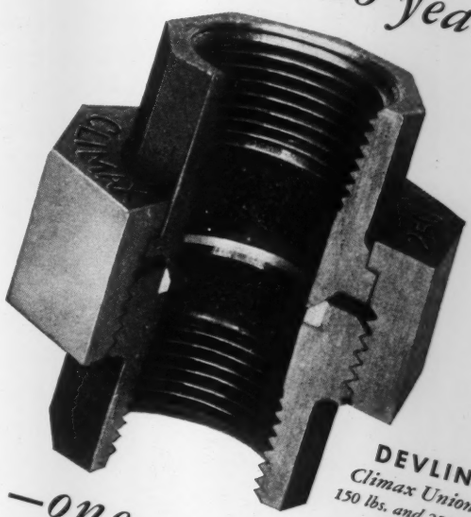

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CAST IRON	WROUGHT IRON
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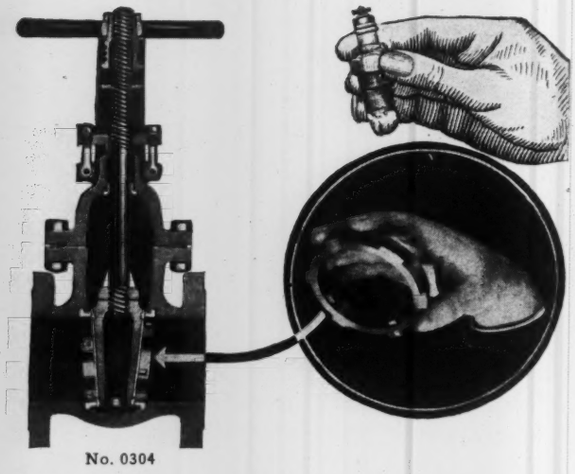


No. 0304

You Don't Scrap Your Auto When New Spark Plugs are Needed

It is just as ridiculous to scrap a valve when the seat is worn as it would be to junk an automobile instead of putting in new spark plugs. For new seats can be quickly and inexpensively inserted in Fairbanks *Renewable* Gate Valves.

Of course, if you use non-renewable valves with the seats cast integral or threaded in the body, it is almost impossible to reface or renew the seats without stripping the seats or body threads, especially if they have been in service a long time.

FAIRBANKS

Renewable Gate Valves

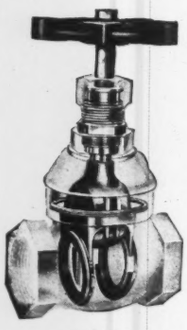
can be repaired by one man in five minutes or less without removing valve from the pipe line or disturbing pipe coverings; while it requires two men to repair a non-renewable valve.

Think of the labor and money these features would save you!

All parts of Fairbanks Renewable Gate Valve are interchangeable. The gate or plug will not warp or spring. Bodies have large pipe openings allowing full flow and reducing frictional steam loss. Stuffing box can be repacked under pressure while wide open. Strong body hexes prevent damage from wrench abuse.

Sturdy construction and reliable performance of Fairbanks Valves are assured by our experience of more than half a century.

Write for our interesting catalog.



No. 0201

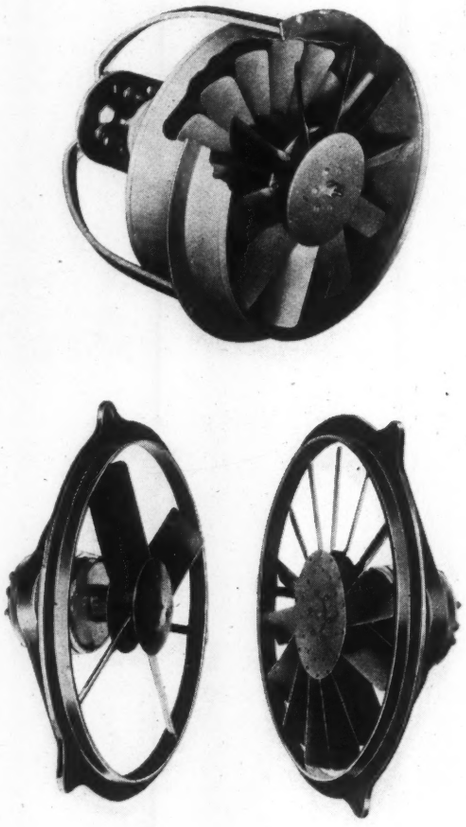
THE FAIRBANKS COMPANY

Manufacturers of Valves, Hand Trucks and Wheelbarrows

396 Lafayette Street, New York, N. Y.

Boston, Pittsburgh—Distributors in Principal Cities.

The two lower views in the illustration show disc pressure fans, the high pressure type (right) and low pressure type (left).



Features, states the manufacturer, are efficient operation against static pressure, and non-overloading power characteristics.—De Bothezat Corp. (Unit of American Machine and Metals, Inc.), 79 E. 130th St., New York, N. Y.

Flexible Header Tee

No. 317—New flexible header tee illustrated is designed for connecting indirect water heaters to cast iron sectional heating boilers, contains a ball and socket arrangement packed in asbestos graphite packing. It is intended to eliminate need for painstaking accuracy in tapping the boiler section. The ball and socket arrangement permits flexibility and forms an expansion joint between each boiler section, protecting the boiler against cracking at the tappings. No unions, ells, tees, etc., are needed. It allows placing the header close to the water line to take advantage of the highest boiler temperature. —Melchior, Armstrong, Dessau Co., 300 Fourth Ave., New York, N. Y.

[Add the new products and new companies listed in "Equipment Developments" to your Directory Section (which you received in your January 1935 HEATING, PIPING AND AIR CONDITIONING) and thus keep your records of sources of supply up-to-date throughout the year.]

Over 3000 BINKS Cooling Systems Now in use!

BINKS ATMOSPHERIC SPRAY COOLING TOWERS are built in sizes ranging from 6 tons up to 200 tons refrigeration capacity, and are extensively used today in the ever growing air conditioning field.

BINKS INDOOR FORCED DRAFT Cooling Towers are also made up to 40 tons refrigeration capacity and are unexcelled for the smaller tonnage requirements where piping difficulties are encountered and piping cost must be minimized.

We offer a standardized complete SHOP CONSTRUCTED TOWER (with full spray nozzle distribution) for most every application. This is evidenced by the more than 3,000 Binks Cooling Towers now in operation.

The Binks line is recognized as being the most complete and includes spray and atomizing nozzles of advanced design for practically every industrial requirement.

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Armour & Co.
Swift & Co.
Pure Oil Co.
Firestone Tire & Rubber Co.
Brown Shoe Company
Coca Cola Bottling Co.
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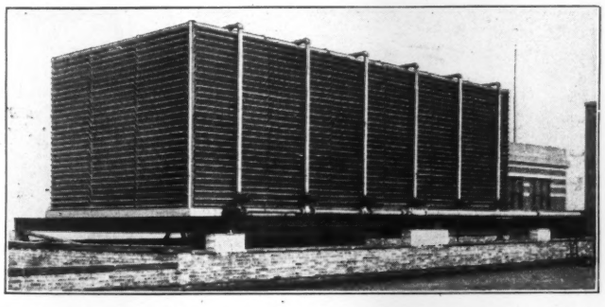
Roosevelt Hotel Co.
University of Michigan
Red Top Malt Extract Co.
Buda Company
Georgia Power Co.
East Ohio Gas Co.
Sheffield Farms Co.
Public Service Co. of Colo.
Great Lakes Forge Co.
Carrier Engineering Corp.
First National Stores
United States Gypsum Co.
Great Atlantic & Pacific Tea Co.

Send for Bulletin 60 On Atmospheric Towers 5 to 1200 G.P.M.

Send for Bulletin 70 on Indoor Forced Draft Towers 5 to 150 G.P.M.



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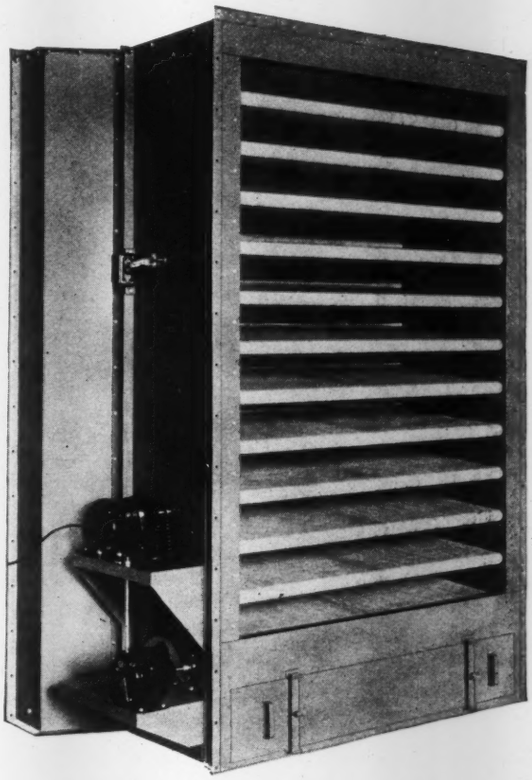
SELF-CLEANING
AIR FILTER



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Big Time Cast Iron Line

There are a lot of things one might say for "K" cast iron fittings but these three points deserve particular mention:

Operations conducted on an extensive scale.
Heavy inventories for spot shipments.
Every fitting hand-inspected and guaranteed.

No matter how large the order, you can "bank" on SERVICE right along with quality when you order "K" fittings.

Standard and Extra Heavy Screw fittings.
American Sprinkler Fittings.
Standard Flange Fittings.
Standard and Extra Heavy Companion Flanges.
Drainage Fittings.
Extra Heavy Screw, American Sprinkler, and Flange Fittings all hydrostatically tested to 300 lbs.
"K" line an Underwriters' Approved and Associated Factory Mutual Approved line.

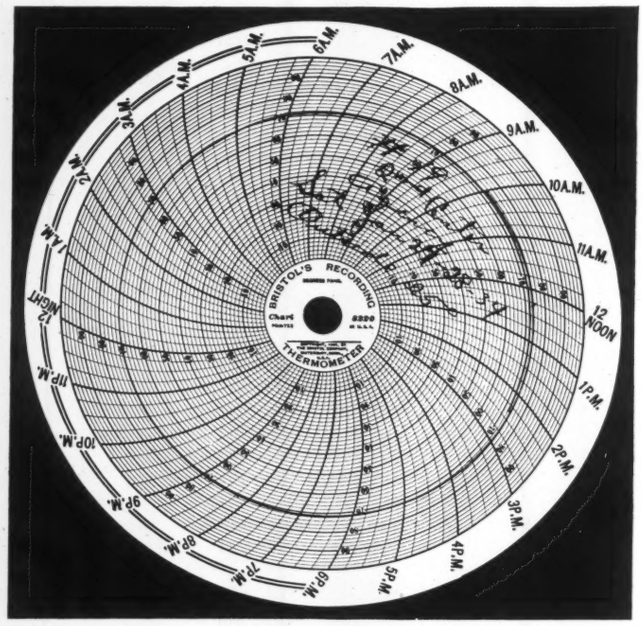
KUHNS BROTHERS COMPANY
Dayton, Ohio

Combined marketing facilities on both "K" and M. I. F. Malleables
Complete stocks at both Dayton, Ohio, and Branford, Conn.

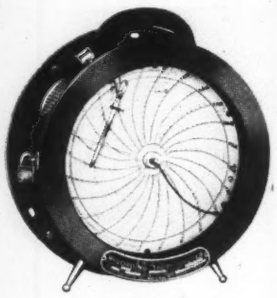
KUHNS

"Satisfactory

for taking room temperatures in locations from which we receive heating complaints"



Sample charts obtained by a well-known life insurance company in adjusting heating complaints with Bristol's Thermometers.



Bristol's Portable Round Form Recording Thermometer, Model 169, with self-contained bulb and 8 or 10 inch chart.

Arguing never pays. If, for example, a tenant or department head complains that he is not getting enough heat, only facts, not controversy, can settle the matter.

The thing to do is to install a Bristol's Recording Thermometer. A disinterested unbiased "witness" so to speak, it gives a continuous 24 hour chart record that reveals every temperature fluctuation. Every minute of the day it shows what the temperature is and has been. Not subject to contradiction, it saves time, temper and money.

As the building superintendent of a large life insurance company put it "Bristol's Recording Thermometers are very satisfactory for taking room temperatures in locations from which we receive heating complaints."

Furnished in portable models, or for wall mounting.

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Branch Offices in Principal Cities . Canada: The Bristol Co. of Canada, Ltd., Toronto, Ontario . England: Bristol's Instrument Co., Limited, London, S. E. 14

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PIONEERS IN PROCESS CONTROL SINCE 1889

[*Continued from p. 29, front section*]

package so far as air conditioning is concerned is the room or structure that is to be conditioned. It is not the heating or cooling. If some organization builds a structure and delivers it to you set in position and in this building is included the equipment to provide air conditioning, that may be considered a packaged article. But the emphasis right now is coming from our need for applying air conditioning to the existing structures, and I know of no substitute for the engineering type of analysis."—Lester T. Avery, in a recent address.

RECORD-breaking attendance, lively discussion, late adjournment were proof of the interest in the subject discussed by the Illinois chapter of the *A.S.H.V.E.* last month—the recently published standards for certified air conditioning for comfort . . . A "discussion in print" of the same subject is planned for our next issue . . . A report on performance of air conditioning systems in the dust storm area is also scheduled for next month . . . Three papers on air conditioning and an inspection of a hotel cooling job are scheduled for the spring meeting of the *American Society of Refrigerating Engineers* in Detroit this month; the papers are "Air Conditioning and Odor Control," by Philip Drinker; "Window Glass as Insulation," by C. D. Haven; and "Rational Development and Rating of Extended Air Cooling Surfaces," by H. B. Pownall . . . The program for the annual meeting of the *American Society for Testing Materials* in Detroit next month calls for sessions on control of corrosion in air conditioning equipment, corrosion tests of steel pipe, effect of temperature on metals, and many other topics of interest to the Society . . . The *Refrigerating Machinery Association* is to meet at The Homestead, Hot Springs, Va., this month . . . Headquarters of the *Air Conditioning Manufacturers' Association* (formerly the Unit Air Conditioners Manufacturers' Association) have been opened in the Southern building, Washington, D. C.; William B. Henderson is executive secretary . . . Defacement and deterioration of buildings by smoke was discussed by H. B. Meller and L. B. Sisson of the Mellon Institute at the meeting of the *American Chemical Society* in New York last month . . . The Allegheny County (Pa.) courthouse has paid a "smoke tax" of $3 a day for 50 years, it was computed; acid in smoke destroyed the condensing system on the roof of a Baltimore plant; air conditioning equipment in highly smoky sections has corroded so as to require replacement in three months, it was said.

TOO much heat in one part of the building, not enough in the other wing, the piping not graded properly, a vacuum pump in the wrong location, and a number of unnecessary turns in the steam piping—just a few things found wrong in an inspection of the heating system of an institutional building. How many other buildings are failing to get proper service from their heating plants because of similar deficiencies? An inspection now, correction before the next heating season, will pay dividends in lower heating costs, better heating service.

Booklets, Reports and Papers

Fuel Oil

"Fuel Oil Characteristics, Specifications, and Testing," by Dr. R. T. Goodwin, Shell Petroleum Corp., presented at conference on fuel oil and oil burners, University of Wisconsin, February, 1935. 15 mimeographed pages. Copies available by request on business stationery from Shell Petroleum Corp., Shell Bldg., St. Louis, Mo.

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ARE ADAPTABLE TO ANY

COOLING, HEATING OR AIR CONDITIONING NEED

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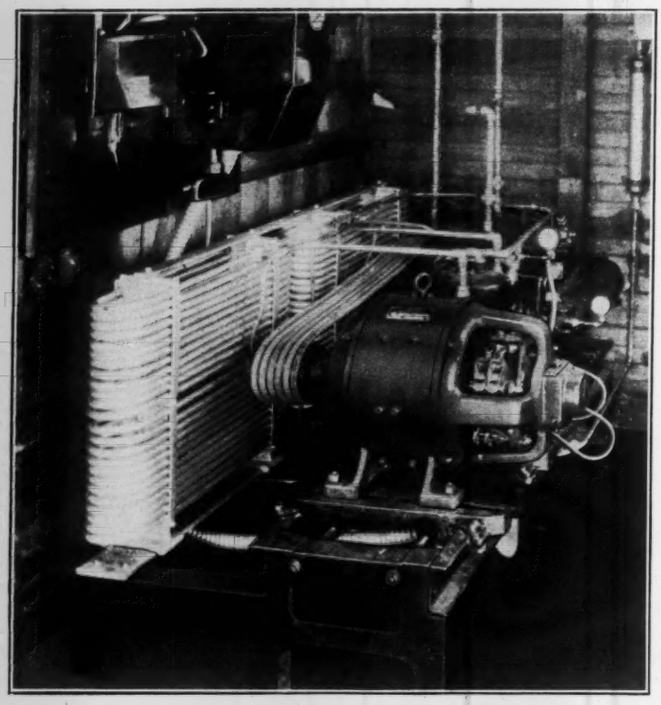

Century 15 Horse Power 4-Pole 115-Volt Direct Current Motor, V-Belt Connected to Refrigerator Compressor

CENTURY
DIRECT CURRENT MOTORS
for AIR CONDITIONING

Wherever direct current is the power source for driving any type of Air Conditioning Equipment, Century Direct Current Motors will meet every exacting requirement...Long life and satisfactory operation are assured by: Rolled Steel Frames — Refined Grey Cast Iron End Brackets — Liberally Proportioned Armature and Commutator — Phosphor Bronze Bearings, Ring-Oil or Wool Yarn Lubricated or Ball Bearings Grease Lubricated...Sizes up to 150 Horse Power.

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Century

SINGLE PHASE, POLY-PHASE, DIRECT CURRENT
1/250 to 600 H. P.
MOTORS

In this address, Dr. Goodwin explains and discusses in interesting and readable manner the following topics: Characteristics, Separation of Crude Oils, Treating Petroleum Products, Specifications, Industrial Use, How Specifications are Formulated, Importance of Using Proper Oil, Tests for Gravity, Flash and Fire, Viscosity, Pour, Color, Carbon Residue, Sulphur Content, Basic Sediment and Waste, Distillation and Btu, Additional Precautions.

A flow diagram from crude oil to finished products is shown, and a Specifications chart and a chart showing weights and heating units of various gravity fuel oils are reproduced.

Special attention is given to an outline of the specifications for fuel oils (CS12-35) which became effective February 15.

Psychrometric Charts

"Psychrometric Charts for High and Low Pressures," by Donald B. Brooks, National Bureau of Standards Miscellaneous Publication No. M 146. 8 x 10½ in., with four full page charts. Available from Superintendent of Public Documents, Government Printing Office, Washington, D. C., for 5c.

These charts were developed for use in the determination of humidity from psychrometric observations at pressures ranging from ⅛ to 10 atmospheres, and their use can be extended to any other pressure by either of two methods which are described. They supplement the charts published in Bureau of Standards Miscellaneous Publication No. 143, which are designed for use at pressures near one atmosphere only and are slightly more convenient and equally accurate over their pressure range. The four charts are high range and low range for the Centigrade scale, and high range and low range for the Fahrenheit scale.

Not only can the charts be used to evaluate relative humidity or pressure of water vapor from psychrometric data; they can be used also to determine the dewpoint, the saturation pressure of water, how to obtain a desired relative humidity by heating or cooling a given atmosphere, and the precision required in psychrometric measurements to obtain a desired precision in the result.

Public Water Supplies

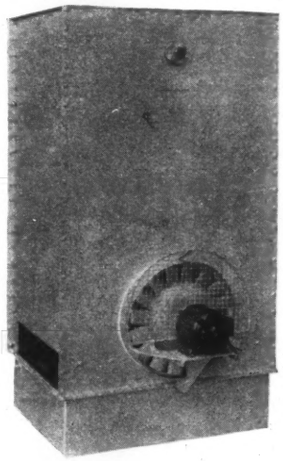
"The Industrial Utility of Public Water Supplies in the United States, 1932", by W. D. Collins, W. L. Lamar, and E. W. Lohr. Geological Survey Water Supply Paper 658 135 pp., 5¾ x 9 in., paperbound. Available from Superintendent of Public Documents, Government Printing Office, Washington, D. C., for 15c.

Information on the chemical characteristics of water supplies is essential to the location of most industrial plants. In certain areas there is no demand for water softening equipment; in many places there is little need for materials and appliances to combat corrosion of pipes. Selection of boiler plant equipment or water softening equipment will be influenced by the chemical character of the water to be used or treated.

The present report gives data for 670 places with 46 per cent of the total population of the United States. The report includes every water supply system serving an area that had in 1930 a population of 20,000 or more. Several cities with less than 20,000 inhabitants are also included in order that the different States may be more adequately and uniformly represented. At least five cities in every State are included.

The essential part of this report is a table of analyses. Next, perhaps, in value is the general discussion of hardness, including a generalized map showing hardness.

Although the table of analyses relates to public water supplies as delivered to consumers, it can be made to yield much additional information. For many of the places the data indicate the probable chemical character of a private supply that might be developed for a manufacturing plant located in or near the city. For nearly all the supplies which are softened the table shows also the composition of the untreated water.



Ask Your Air Conditioning System Manufacturer

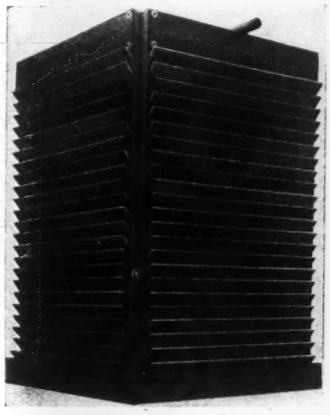
THE country's leading manufacturers of air conditioning equipment recommend the use of Marley cooling towers with their condensing units. Hundreds of their salesmen carry Marley specifications and Marley engineering data with them at all times. Marley leads the field in sales.

This recognition proves the efficiency of Marley spray nozzle equipped towers—is a safe guide to correctly engineered, soundly designed water cooling systems for all who require them.

Above: — Small Marley forced draft tower for indoor or outdoor use.

Right: — Marley spray type tower.

Left: — Marley patented spray nozzle, used in all Marley cooling systems.



Smaller, standardized Marley towers carried in stock for prompt shipment at all times. Write for Bulletin No. 49.

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COOLING TOWERS

VACUUM

Joint subjected to practically perfect vacuum (29.8 inches of mercury). Suction held constant. No leak.

DEFLECTION

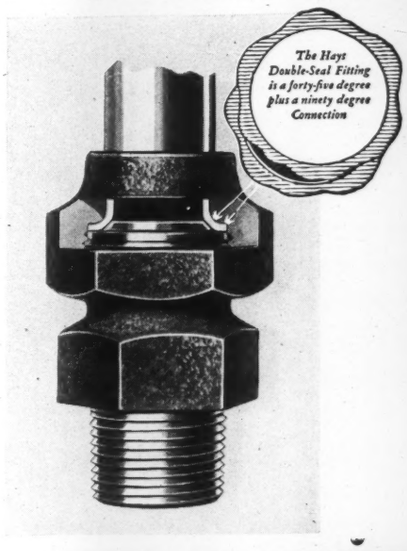
4.83 inches of deflection failed to loosen the joint.

TORSION

Joint subject to 5200 inch-pounds of twisting force. No slippage.

FIRE AND FROST

HAYS joints remain tight up to melting point (about 1800° 7 successive freezings at 10° below failed to weaken the joint.



VIBRATION

Kerosene in line at 50 lbs. pressure.
Amplitude of vibration—1/4 inch.
Frequency—1,000 per minute.
Duration of test—30 hours.
No sign of failure.

Patented **HAYS** Patented
DOUBLE SEAL CONNECTIONS

They are Copper to Copper with no intermediate sealing agent.

Hays Double Seals have been subjected by Laboratory Engineers to punishing tests to determine their great reserve strength. Some of the results are noted at the left. Complete reports of the Underwriters and Columbia University tests are available to those interested.

Double seals offer a greater factor of mechanical strength than any other method of joining copper pipe. That is why we suggest and approve their application in your field of activity.

Put your copper piping problem up to Hays Engineers.

HAYS MFG. COMPANY
Erie, Pennsylvania

AIR TIGHT JOINTS
Approved by
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New ...

TYPE N-375—for any specified capacity up to 5 tons of Freon.

TYPE T-500—for any specified capacity from 5 to 10 tons of Freon.

(Fitted with connections for I.P.S., S.A.E. flare, or streamline solder).

APPEARANCE
INTERNAL CONSTRUCTION
PRECISION
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YOU can control liquid Freon *automatically* to the highest point of efficiency — with the new ALCO Thermo Valves. They can be depended upon absolutely to increase or decrease the flow of liquid Freon to any low side evaporator according to variations in load conditions occurring at any time.

ALCO Thermo Valves are actuated only by super-heat of the refrigerant as it leaves the evaporator, responding immediately to load changes. And they maintain maximum efficiency in any "low side" no matter how many similarly equipped low sides may be operated by a single compressor.

These valves are new in every respect—designed and built by the originators and sole manufacturers of the only genuine Thermo valves made. They have been in process of development and testing for many months. *And the power assembly is guaranteed against failure for two years.* It cannot lose its charge except through actual abuse.

ALL ALCO Thermo Valves are now equipped with "two year" power assemblies. These new power assemblies are interchangeable on all Alco Thermo Valves now in operation.

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"Known Wherever Temperature is Controlled"

· ALCO VALVES

The Editor's Correspondence

Extinguishing Kitchen Duct Fires

The Editor: In the April issue of H. P. & A. C. is a brief article on the use of automatic sprinkler heads for admitting steam into range hood exhaust ducts to smother grease fires. To make use of this information it should be made clear that the ordinary sprinkler head will not serve the purpose because the temperature in the duct above the range (especially in busy kitchens) is often higher than the 135 to 165 F for which ordinary heads are adjusted. "Extra hard" or 325 to 360 F heads should be used.

The article referred to intimates that the use of sprinkler heads for this purpose is a new idea, while as a matter of fact they have been so used for many years. The obvious advantage in their use commended itself to my office about twenty years ago, and I have since seen them used by many others.

Another point to consider is the used of two or more heads in large ducts; and we have also found that fires are more quickly extinguished when a self-closing damper (normally held open by a fusible link) is placed in the duct near the range, with the sprinkler heads beyond it, so that in case of fire the closing of the damper stops the violent inrush of air and enables the duct to fill with steam. This may make the smoke more dense in the kitchen, but prevents warping of a long expensive duct and danger of fire to adjacent surfaces.

A grease fire in a duct usually starts from the overturning or boiling over of a kettle of grease on the range, but the real danger is occasioned by the fire in the duct rather than in the kitchen, which as a rule is fireproofed.—JOHN G. EADIE.*

*Eadie, Freund, and Campbell, Consulting Engineers.

Book Reviews

Arc Welding Training Course

"Arc Welding Manual and Operator's Training Course," by W. J. Chaffee. Published by The Hobart Brothers Co., Box EW-46, Troy, Ohio. 94 pp., 5½x8¼ in., flexible binding. Price, $1.00.

This manual presents facts about arc welding and arc welding equipment in a non-technical manner; it is designed to be useful to the beginner as well as the experienced operator or technician.

A chapter is devoted to each of the following subjects—the welding arc, welding equipment, weldability of metals, types of joints and welds, strength of welds, speed and cost of welding, using the metallic arc, welding with bare electrodes, and welding with coated electrodes. Twenty-three exercises for training arc welding operators are included, sixteen on bare electrodes and seven on welding with coated electrodes.

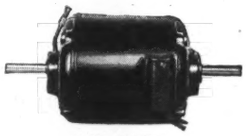
Gas Water Heater Manual

"Water Heaters" (Vol. 2 of "Gas Appliance Installation and Service Manual"), prepared by a committee of the American Gas Association and published by the Association, 420 Lexington Ave., New York, N. Y. 205 pp., 7½ x 5¼ in., flexible binding. $1.00.

This pocket-size manual covers all forms of water heaters and accessories intended for use with manufactured, mixed, or natural gases. Part 1 is devoted to types and sizes of heaters, Part 2 to installation, Part 3 to servicing, and Part 4 gives specific servicing instructions for common types of water heaters and controls. Pages 78 to 199 describe adjustment of and servicing of individual water heater controls, each make being considered separately.

Resilient-Mounted

Flange-Mounted


Without Base

Rigid-Mounted

S635-4B

Wagner Motors, because of their interchangeability

REDUCE INSTALLATION COSTS

Wagner small A.C. motors can be changed for the same size D.C. motor... since frame, base and shaft dimensions permit interchangeability!

Cost-conscious air conditioner manufacturers realize that their installation costs can be reduced if their line of motors have frame, shaft, and base dimensions to permit interchange of various types and sizes of motors on the same refrigerator.

Wagner motors built in the same size of frame (whether repulsion-start-induction, squirrel-cage, direct current, etc.) have the same size and spacing of mounting holes, and are therefore interchangeable. Thus a 57-frame repulsion-start-induction motor is interchangeable with a 57-frame squirrel-cage motor or a direct current motor. Further, base dimensions of Wagner motors are selected to permit a large number of size changes. Thus motors of 1/10, 1/8, 1/6 and 1/4 horsepower (in 1800 r.p.m.) of the same type are all interchangeable as far as base dimensions are concerned. Shaft height and dimensions will vary slightly in the 1/4 horsepower ratings of the repulsion-start-induction.

At the left are illustrated four of several types of mountings preferred by air conditioner manufacturers. Each type of mounting is available on all types of Wagner motors.

There are many other considerations besides interchangeability provided for in Wagner design and construction such as: quietness, dependability, appearance, and performance. Write for Bulletin 167 which discusses these considerations and completely describes Wagner small motors.

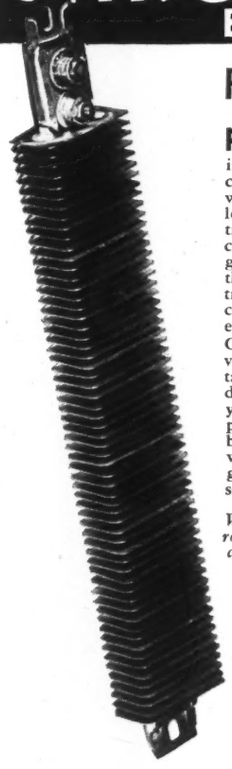
MOTORS TRANS-FORMERS

Wagner Electric Corporation

6400 Plymouth Avenue, Saint Louis, U.S.A.

FANS BRAKES

CHROMALOX ELECTRIC HEAT



FINSTRIPS have proven invaluable

in supplying electric heat in scores of cases, particularly where air blast heating was the problem. Finstrips are made in lengths from 10½" to 43" and in capacities from 600 watts to 3700 watts. They can be supplied in complete units or groups for the particular job. They lend themselves easily to a number of industrial process applications, as well as in conjunction with heating and ventilating equipment.

Chromalox heating units, in a great variety of forms, are bringing the advantages of electric heat to innumerable industrial heating problems. They will help you solve your problem. We will be glad to work with you; our engineers are at your service.

Write us, with a rough sketch of the conditions to be met.

Mail with your Business Letterhead

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Send me the Chromalox Book on Electric Heat.

Name .....

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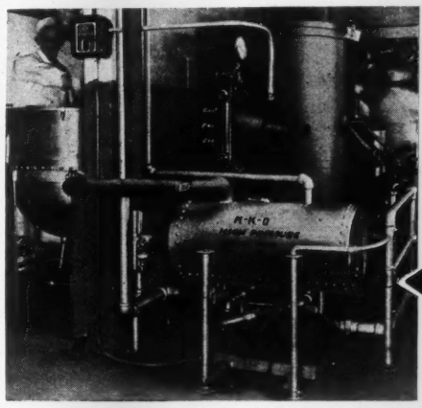
No More Feed Water Worries With—



THE M-K-O Automatic BOILER FEED

Keeps a Constant Water Level in High or Low Pressure Boilers—*Automatically*

This Unit automatically pumps feed water against high boiler pressure—returns condensate to boiler—supplies make-up water as needed.

It requires no steam to operate (it operates electrically) and can be used with gas or oil, stoker or hand fired boilers.

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Aerofin Standardized Light Weight Fan System heat exchange surface is the first choice of architects, engineers and building owners for Heating or Cooling because of its proved superiority. Progressive heating and cooling contractors install it because it gives complete satisfaction.

Aerofin is years in advance of ordinary heating and cooling surface because of its exclusive features. It is available in aluminum, copper or other special metals. Whatever you have wished for in a fan system surface you will find in Aerofin.

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Aerofin Was the Choice When It Came to Fan System Surface for the U. S. Post Office in Detroit.

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Living with the Weather

"Living with the Weather," by Clarence A. Mills, M.D., Ph.D., Professor of Experimental Medicine, University of Cincinnati. Printed for the author by the Caxton Press, Cincinnati, Ohio. 206 pp., 5x7½ in., clothbound.

Under the above title, Dr. Mills explains the part that the weather plays in our daily lives and advises realization of its effects so that living habits may be adjusted to them. His analysis is based upon six years of studying climatic and weather effects in the United States and the Orient, observations of patients in clinic and hospital, of laboratory animals under controlled conditions, and statistics on weather and disease. No attempt is made to present the evidence upon which his statements are based, nor to give references supporting them.

Although written for the general public, this book is of particular interest to the air conditioning engineer; in fact, a chapter is devoted to the proper use of indoor atmospheric control. In concluding this chapter, the author suggests the experiment of cooling school buildings in tropical and sub-tropical lands and keeping the children in school through the summer heat. This would supply six hours of cooling daily, which with animals has been found to be very stimulating. Growth and development would be more rapid, and general vitality higher, he says.

Other subjects discussed, each in relation to the weather, are human behavior, man's vitality; competitive sports and games; coffee, alcohol, and narcotics; constipation and intestinal intoxication; travel; disease; weather stimulation, human energy, and business cycles; human migration; living problems in cool, stormy regions, and in regions with prolonged periods of moist heat; and the past, present and future of man.

Conventions and Expositions

Heating, Piping and Air Conditioning Contractors National Association: Annual convention, May 20-22, Hotel Gibson, Cincinnati, Ohio. Acting Secretary, S. Lewis Land, 1250 Sixth Ave., New York City.

American Society of Refrigerating Engineers: Spring convention, May 22-24, Statler Hotel, Detroit, Mich. Secretary, David L. Fiske, 37 W. 39th St., New York City.

National Warm Air Heating and Air Conditioning Association: Annual convention, June 4-6, Deshler-Wallick Hotel, Columbus, Ohio. Managing Director, A. W. Williams, 50 W. Broad St., Columbus, Ohio.

Smoke Prevention Association: Annual convention, June 4-7, Statler Hotel, St. Louis, Mo.

Coal Utilization Short Course: June 11-13, College of Engineering, University of Illinois, Urbana, Ill. Under auspices of the departments of mining and metallurgical, and mechanical engineering.

National District Heating Association: Annual convention, June 11-14, Bellevue-Stratford Hotel, Philadelphia, Pa.

American Society of Heating and Ventilating Engineers: Semi-annual meeting, June 17-19, Royal York Hotel, Toronto, Ont. A. V. Hutchinson, Secretary, 51 Madison Ave., New York, N. Y.

American Society of Mechanical Engineers: Semi-annual meeting, June 19-21, Cincinnati, Ohio. Secretary, C. E. Davies, 29 W. 39th St., New York City.

American Society for Testing Materials: Annual meeting, June 24-28, Book-Cadillac Hotel, Detroit, Mich. Exhibit of testing and

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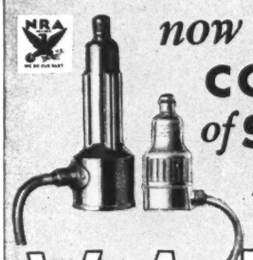
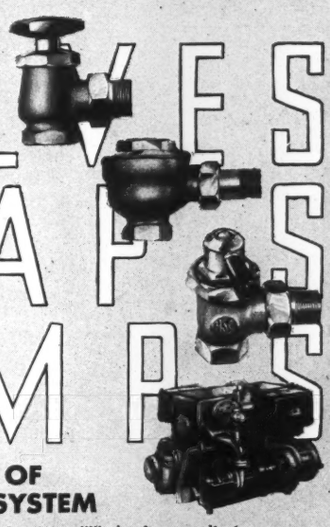
now offers the **MOST COMPLETE LINE** *of* **STEAM HEATING SPECIALTIES**



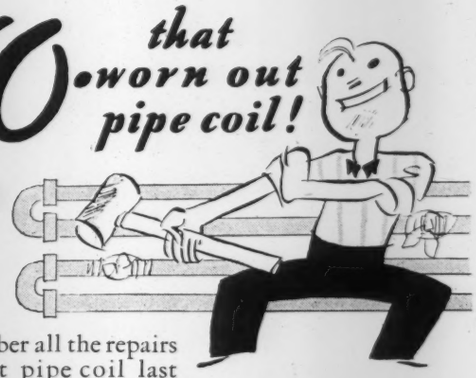
VALVES TRAPS PUMPS



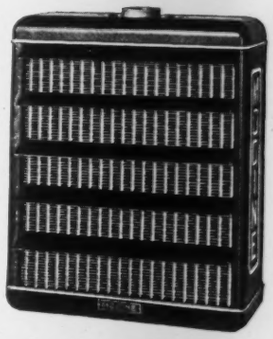
FOR EVERY TYPE OF STEAM HEATING SYSTEM

For full information See Your Wholesaler or write to
Hoffman Specialty Co., Inc., Waterbury, Conn.

K·O *that worn out pipe coil!*

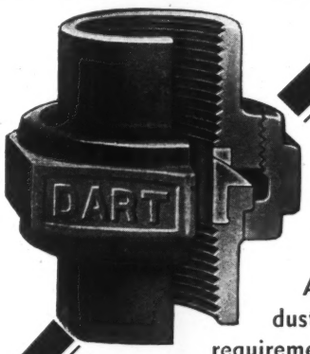


Remember all the repairs on that pipe coil last winter? And how poor heating cut down the men's production? Why not replace it *now?* Modine Unit Heaters insure faster heating, even heating, comfortable heating *at less cost.* The Ingersoll-Rand Co., Phillipsburg, N.J., is one of hundreds who have modernized with Modine. *Write for free book.*



MODINE MANUFACTURING COMPANY
Dept. 60 RACINE, WISCONSIN

The New **MODINE** *unit heater*



Expecting *Plus* and Getting *More*

An imposing number of industries intrust their *special* requirements to DART UNIONS.

They know from experience the values:

¶ Bronze-to-bronze seat, machined and ground to a perfect ball joint;
¶ Resistance to corrosion;
¶ Insurance against leaks;
¶ Ease of installation.

DART UNIONS are designed and built in expectation of rigorous service demands. That is safety alike for normal and unusual requirements.

Will you try a sample DART UNION?

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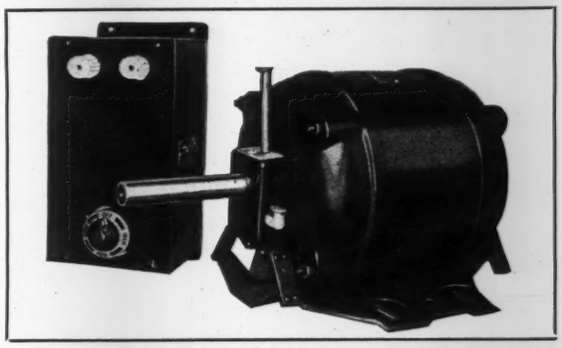

FAN DUTY MOTORS for UNIT AIR CONDITIONERS

ARE USED BY THE LEADING AIR CONDITIONING EQUIPMENT MANUFACTURERS BECAUSE OF THEIR SUPERIOR QUALITY AND PERFORMANCE.

FIRST—Complete absorption of torque pulsations by steel spring base, together with mechanical and electrical refinements in design, combine to give **PERMANENT SILENT OPERATION.**

SECOND—Adjustable speeds over a wide range, and any desired single or double shaft extension will enable you to obtain the **EXACT SELECTION** of the motor to properly operate your unit.

Our Engineers will gladly confer with you. Their experience can be helpful—write Department 20 for descriptive Bulletin.

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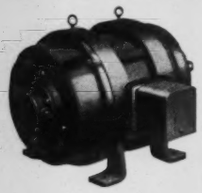
MOTOR SPECIALISTS FOR 50 YEARS



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AIR COOLING AND CONDITIONING

Warning! Medicine Man sees hot winds ahead. A hot dusty summer in the offing. This is the forecast for 1935 of the Medicine Man of the Winnebago Tribe at the Wisconsin Dells. Are you prepared for such an eventuality? Will 1935 be a repetition of 1934?

WITTENMEIER, a name associated with Refrigeration in all its phases and applications for over 35 years, offers complete Air Conditioning and Refrigerating Systems for industrial purposes and bodily comfort, either in central or unit systems from ¼ ton capacity up.

REFRIGERANTS:—CO_2—Freon—Ammonia—Methyl Chloride—Steam—Water Vapor.

When Architects, Engineers, Owners and Operators once realize that Air Cooling and Conditioning requires perfect coordinating of Heating, Ventilating and Refrigerating, then, and only then, will they appreciate the necessity of entrusting their Air Conditioning Problems with experienced contractors, not those who are experienced in only one or two of these fundamentals but contractors who are thoroughly familiar with all three.

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Let us make a survey of your requirements and give you our unbiased opinion of the system best suited for your purpose. There is no obligation. Wittenmeier, with Air Cooling and Conditioning Experience that dates back to 1908, can offer helpful suggestions. Architects, Engineers, Contractors and others should avail themselves of this service.

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Great Lakes Power & Mechanical Exposition: June 24-28, on Steamer "Seeandbee," starting from Cleveland. Ernest H. Smith, Managing Director, 3910 Carnegie Ave., Cleveland, Ohio.

Midwest Power Show: October 14-18, Chicago, Ill. G. E. Pfisterer, Managing Director, 1 N. LaSalle St., Chicago, Ill.

American Gas Association: Annual convention, October 14-18, Atlantic City, N. J.

International Heating & Ventilating Exposition: January 27-31, International Amphitheater, Chicago, Ill. Manager, Charles F. Roth, Grand Central Palace, New York, N. Y.

Recent Trade Literature

For your convenience in obtaining copies of bulletins, see coupon on page 95

No. 416.—AIR CONDITIONING: Baker Ice Machine Co., Inc., 1590 Evans St., Omaha, Nebr. Folder "Sell Cool Comfort to Your Customers" illustrating air conditioning installations in commercial buildings and pointing out how air conditioning pays dividends.

No. 417. AIR CONDITIONING: Frigidaire Corp., Dayton, Ohio. 24 page booklet "Air Conditioning," defining and describing air conditioning, illustrating self-contained air conditioners and conditioners with remote condensing units, and showing applications of this company's equipment to private and general offices, stores and other businesses.

No. 418. AIR FILTERS: Coppus Engrg. Corp., 374 Park Ave., Worcester, Mass. 4 page bulletin "Unit Type Air Filters," describing design and assembly of dry type unit air filter, cleaning efficiency, method of cleaning, and advantages of design. Also, 4 page bulletin on air filters for air compressors, internal combustion engines, etc., pointing out why air filters are necessary, design, assembly and construction, cleaning efficiency, and showing dimension drawings.

No. 419. ALLOYS: Climax Molybdenum Co., 500 Fifth Ave., New York, N. Y. 4 page pamphlet "The Moly Matrix" discussing use of a stainless steel alloy with 3 per cent molybdenum for resistance to chemical action, illustrating pump parts for use in production of rayon (19.5% Cr, 9% Ni, 0.06% C, 3% Mo), and valves and fittings for paper mill service (25% Cr, 10% Ni, 0.12% C, 3% Mo).

No. 420. BOILER WATER LEVEL CONTROL: McDonnell & Miller, 1316 Wrigley Bldg., Chicago, Ill. 24 page catalog describing need of heating boiler water level control, development of this company's equipment, reasons for installing a feeder or cut-off in gage glass tappings, and a detailed description of the design and construction features of the equipment, including service recommendation chart, installation instructions, dimensional data, list of users, etc.

No. 421. BOILER CLEANING: Nielco System of Maintenance, 5421 Cicotte Ave., Detroit, Mich. Folder describing method and equipment for cleaning steam and hot water boilers, hot water supply systems, sewers and drains.

No. 422. BRAZING FLUX: Handy & Harman, 82 Fulton St., New York, N. Y. 4 page folder describing a new flux for low temperature brazing of steel, stainless steel, monel, nickel, copper, beryllium-copper, brass, bronze, aluminum bronze, and other ferrous and non-ferrous metals and alloys, which is fluid and active at 1200 F.

No. 423. CONDUIT: H. W. Porter & Co., Inc., Newark, N. J. Eight page bulletin "Thermo-O-Tile Steam Conduit System," presenting detailed instructions for installation of underground steam conduit system. Also, 8 page bulletin giving specifications for the system.

No. 424. COOLING AND AIR CONDITIONING UNITS: Buffalo Forge Co., 171 Mortimer St., Buffalo, N. Y. 12 page

"Why are you insisting on Reading **GPWI*** Pipe here —and here?"

"I've got a reputation to maintain—and I know that no other pipe lasts so long in these places."

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Dust laden air drawn into your compressors, Diesel engines, blowers, motors and other air-using equipment reduces their efficiency. It puts you to the expense of overhauling equipment 3 to 5 times as often as would be necessary if equipped with Protectomotor Air Filters.

It costs $100 or more to pull down the average sized compressor, grind the valves, clean the parts and replace them. Consequently you can save $300 to $500 or more on every compressor in a short time by equipping them with Protectomotor Air Filters.

Protectomotor Filters are guaranteed to remove 999 out of every 1,000 particles of dust and grit from the air. In addition, they reduce oil consumption 25%, save compressed air and muffle noises. They operate from six months to a year without cleaning, and can be cleaned quickly with compressed air without removing the filter unit.

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bulletin illustrating, describing and giving ratings for suspended unit coolers, floor type units, floor type units with brine spray, and central conditioning cabinets (capacities 3 to 24 tons). Complete tables of specifications, water capacity, Btu temperature chart, dimensions, resistance, and speed and horsepower are shown for the conditioning cabinets.

No. 425. COOLING AND AIR CONDITIONING: Ilg Electric Ventilating Co., 2850 N. Crawford Ave., Chicago, Ill. 28 page pictorial booklet showing some 21 installations of cooling and air conditioning equipment in offices, stores, shops, restaurants, hospitals, etc., each with photograph and sketch of layout. Also, 20 page booklet discussing night air cooling and attic ventilation to relieve excessive temperatures on top floors of apartment and flat buildings, and homes.

No. 426. FANS: International Engineering, Inc., 15 Park Row, Dayton, Ohio. Folder describing features of short pedestal, wall bracket, and high stand propeller type fans. Also, folder describing four blade fans for industrial ventilation, automatic shutters, stack booster fans, foundry fans, etc.

No. 427. FITTINGS: The Parker Appliance Co., Cleveland, Ohio. Additional and revised sheets of engineering data.

No. 428. HUMIDIFIERS: The Standard Engineering Works, 289 Roosevelt Ave., Pawtucket, R. I. Data sheet for individually motorized humidifiers for silk, cotton, wool, worsted, rayon mills, bakeries, printers, lithographers, paper, tobacco, cigar, cigarette manufacturers, laboratories, etc., illustrating standard and "junior" humidifiers and control.

No. 429. MOTORS: Allis-Chalmers Mfg. Co., Milwaukee, Wis. 4 page leaflet describing construction features of "Type ARY" wound rotor induction motors suitable for fans, blowers, pumps and other constant or variable speed applications.

No. 430. PIPE FLANGES: Taylor Forge & Pipe Works, P. O. Box 485, Chicago, Ill. 96 page catalog of forged steel pipe flanges, with a foreword on flange design progress, sections on materials, joint bolting, gaskets, a bibliography, rules for bolted flanged connections, standard specifications, list prices and weights, American Standard flange facings, pressure-temperature ratings, drilling templates, thread standards, dimensions, ground joint flange unions, orifice flange unions, large diameter rolled steel flanges, machine bolts, alloy steel studs, and boiler flanges. A section is also devoted to forged seamless steel fittings for welding, and reference tables are given in a third section. As will be noted from this summary of the content, this catalog is a reference on forged steel flanges.

No. 431. PIPE TOOLS: Beaver Pipe Tools, Inc., Warren, Ohio. Folder describing briefly the fully-adjustable principle of cam type threaders. Also, 4 page bulletin describing in detail portable pipe and bolt threading machines.

No. 432. PIPE TOOLS: Landis Machine Co., Waynesboro, Pa. 8 page bulletin describing recently announced 1¼ in. and 2 in. pipe and nipple threading machines, describing construction and features and giving specifications.

Publisher's Statement of Circulation

This is to certify that the average circulation per issue of HEATING, PIPING AND AIR CONDITIONING for the six months' period July 1st to and including December 31st, 1934, was as follows:

Copies sold	6572
Copies distributed free	704
Total	7276

(Signed) F. P. KEENEY, Publisher.

[Subscribed and sworn before me on this 31st day of January, 1935.

GRACE E. WAYMIRE,
Notary Public.]

No. 433. RADIATORS AND CONVECTORS: National Radiator Corp., Johnstown, Pa. 24 page booklet "Invisible Warmth" showing installations of concealed heating units, or convectors.

No. 434. REFRIGERANTS: R. & H. Chemicals Dept., E. I. duPont de Nemours & Co., Inc., Wilmington, Del. "Artic Service News," presenting information about use of methyl chloride.

No. 435. REFRIGERATION: Baker Ice Machine Co., Inc., 1590 Evans St., Omaha, Neb. Folder illustrating and describing refrigeration equipment for industrial and commercial purposes, and illustrating a number of outstanding installations.

No. 436. STAMPINGS: Geuder, Paeschke & Frey Co., W. St. Paul Ave. & N. 15th St., Milwaukee, Wis. 16 page booklet of modern stampings, showing their place in design, manufacturing, and selling, treating of the possibilities of stampings, discussion of problems, and showing how stamping problems have been solved.

No. 437. STEELS: Republic Steel Corp. (Central Alloy District), Massillon, Ohio. 4 page folder of S.A.E. official alloy and carbon steel specifications, chemical compositions.

No. 438. UNIONS: Thomas Devlin Mfg. Co., Inc., Burlington, N. J. Folder briefly describing 150 and 250 lb malleable iron unions, and 150 lb brass unions.

No. 439. VALVE INDICATORS: Tefft-Jackson, Inc., 830 Hospital Trust Bldg., Providence, R. I. Folder describing and illustrating adjustable valve position indicators.

No. 440. WATER COOLING EQUIPMENT: The Marley Co., Kansas City, Mo. 48 page booklet illustrating water cooling equipment, including forced draft cooling towers (indoor and outdoor), fans for forced draft towers, spray deck towers, modernization of old towers, spray coil cooling systems, all-metal spray type cooling towers, spray ponds and accessories, spray system fittings, and spray nozzles.

No. 441. WATER TREATMENT: Aquatic Chemical & Metallurgical Engineers, 118 E. 28th St., New York, N. Y. Folder giving directions for cleaning and water treatment for heating boilers.

No. 442. WELDERS: The Ideal Electric & Mfg. Co., Mansfield, Ohio. 16 page booklet describing "Noel Speed Arc" electric welders, with complete general and technical information.

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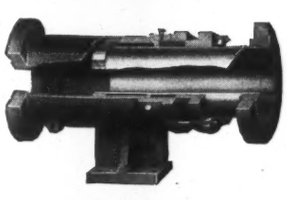

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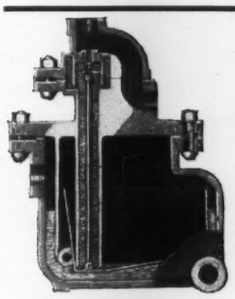

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